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PRE-FINAL DESIGN REPORT - ADDENDUM NO. 1
REVISED SECTION 6.0

12TH STREET LANDFILL
OTSEGO TOWNSHIP, MICHIGAN

Operable Unit No. 4 of the
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

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6.0 DESIGN COMPONENTS

The design for the following components of the remedial action is described in this section:

- Site preparation;
- Excavation of paper residuals from outside the landfill footprint;
- Landfill grading;
- Final landfill cover system;
- Surface water management;
- Landfill gas management;
- Access road;
- Institutional controls;
- Abandonment of existing groundwater monitoring wells; and
- Installation of groundwater monitoring wells.

6.1 SITE PREPARATION

Prior to excavating paper residuals outside the landfill footprint or the regarding of the landfill, the following activities will be performed:

- Silt fencing will be placed around the proposed excavation areas (~~Plan Sheet 2~~Drawing C-02) to prevent the potential migration of sediment beyond the limits of construction as a result of surface water runoff. The silt fencing will be installed in accordance with the specifications contained in Appendix E of the RMT Pre-Final Design Report.
- Brush and trees will be cleared and grubbed, as needed in the proposed excavation areas (~~Plan Sheet 2~~Drawing C-02), including enough space for equipment to access the areas and for the staging of materials and equipment. Cleared vegetation will be chipped and disposed within the limits of paper residuals or taken off site. Larger tree trunks and stumps will be stockpiled on-site and may be incorporated under the landfill cover or taken off-site. Root wads, to the extent possible, will be incorporated under the landfill cover.
- Existing groundwater monitoring wells, leachate head wells, and staff gauges will be abandoned prior to performing grading and/or excavation activities as described in Section 8.1 of the RMT Pre-Final Design Report.

- A staging area for materials and office and equipment trailers will be established adjacent to 12th Street, outside the limits of paper residuals[1].
- A decontamination pad will be constructed at a location ~~within~~ directly adjacent to the proposed final limits of paper residuals ~~adjacent to~~ at the 12th Street Landfill[1].
- Temporary ~~A~~access roads will be constructed as necessary to obtain access to the excavation and grading areas.
- Access agreements, redevelopment plans, and lines of communication will be established with the adjacent property owners.

6.2 EXCAVATION OF PAPER RESIDUALS OUTSIDE THE LANDFILL FOOTPRINT

The areal limits of visible paper residuals outside the footprint of the landfill on the MDNR property, the asphalt plant property, and in the wetlands were previously delineated based on information obtained by Geraghty and Miller and the U.S. EPA in 1994 and 2003, respectively (G&M, 1994b and U.S. EPA, 2004), and have been refined based on the findings of the predesign investigation performed by Weyerhaeuser in 2008. A copy of the report documenting the predesign studies (RMT, 2008e) is contained in Appendix A of the RMT Pre-Final Design Report. Based on the areal limits (~~Plan Sheets 1 and 2~~Drawing C-02) and the thicknesses of visible paper residuals present in areas beyond the proposed final capped footprint of the landfill, an estimated total of 12,200 cubic yards (cy) of visible paper residuals needs to be excavated and relocated back into the landfill (200 cy from the MDNR property, 7,500 cy from the asphalt plant property, and 4,500 cy from the wetland).

A recently completed topographic and property boundary survey of the 12th Street Landfill shows that the east/west running landfill property boundary with the MDNR property is actually up the landfill slope, resulting in more excavation than was originally envisioned when the off-site removal volumes were calculated by RMT (see revised Drawing C-01). As such, it is roughly estimated that the volume requiring excavation from the MDNR property and relocation into the landfill is likely more than double (400 to 500 cy) the amount identified previously. However, this revised volume only increases the total excavation volume from 12,200 cy to approximately 12,500 cy, an increase of slightly greater than 2 percent.

[1] During the 2009 construction season these facilities may be staged within the boundary of the 12th Street Landfill near 12th Street.

In addition to the calculated volumes of paper residuals beyond the 12th Street Landfill property, there would be an associated excavation volume within the landfill slope areas when the property boundary encroaches into the landfill footprint. This is particularly evident for the landfill slope on the north edge of the MDNR property, as the recently completed property boundary survey shows the property line to be almost halfway up the landfill slope on the north side of the MDNR property. As such, in addition to the calculated volume of paper residuals beyond the landfill footprint, there would be a larger volume of material to be excavated from the slopes on the landfill to pull the toe of slope back onto the landfill property. This extent of the slope excavation and the associated volume will be discussed further in Section 6.3, Landfill Grading.

A similar situation occurs on the west side of the landfill, adjacent to the asphalt plant property. (It should be noted that the recently completed property survey did not show any major differences for the western property boundary adjacent to the asphalt plant property, as was observed for the property boundary for the MDNR property). In this situation, the west slope of the landfill veers slightly to the southwest and slowly crosses the property line such that by the southwest corner of the landfill the entire steep sloped area is no longer on the landfill property. It is not known how this steep sloped area looked prior to any landfill operations, but the discussion of historical operations in Section 2.2.2 of the RMT Pre-Final Design Report states that "prior to 1955, a portion of the property on which the 12th Street Landfill is located was a wetland". As such, it is expected that the sloped area to the southwest (note the driveway into the asphalt plant property going diagonally down this slope) likely turned to the east and cut across the southern portion of the 12th Street Landfill connecting over to the northerly slope on the MDNR property on the other side of the landfill. Based on this information, it would not be expected that the slopes area in the southwest corner of the landfill would contain paper residuals, and as such would not need to be excavated.

6.2.1 EXCAVATION OF PAPER RESIDUALS ON THE MDNR PROPERTY

Paper residuals on the MDNR property will be excavated and relocated within the proposed limits shown on ~~Plan Sheet 2~~Drawing C-02, initially based on visual confirmation and finally by verification sampling as described in Section 6.2.3. The paper residuals will be placed within the landfill in lifts not exceeding 12 inches.

Based on the previous investigations and the more recent topographic and property survey information, approximately ~~200~~400 to 500 cy of visible paper residuals are estimated to be excavated and relocated back into the landfill from the MDNR property

(~~Plan Sheet 2~~Drawing C-02). As documented in the predesign studies (RMT, 2008e) (copied in Appendix A of the~~is~~ RMT Pre-Final Design ~~r~~Report), where present, paper residuals on the MDNR property are visible on the ground surface, or covered with a thin (less than approximately 1 inch thick) layer of forest litter (e.g., decaying leaves and branches mixed with occasional topsoil). The paper residuals are light gray, and overlie a poorly graded yellowish-brown sand, and are less than 6 to 8 inches thick. Paper residuals are easily distinguishable from the native soil (grayish-brown topsoil and yellowish-brown sand) based on color and consistency. The water table on the MDNR property is more than 6 feet below ground surface (bgs), and will not be encountered during the excavation activities.

The required excavation and removal of paper residuals from the MDNR property will also require encroachment into the landfill slope to the north (but should not require any significant removal of the landfill slope to the west, as the recent property survey shows that the property line is approximately along the toe of the landfill on this side of the MDNR property). Referring to Drawing C-02, it can be seen that the property line extends as far into the landfill slope as the 718 elevation contour at the northwest corner of the MDNR property, which is more than 10 feet in elevation above the toe of slope elevation. Therefore, it is expected that this material may need to be relocated back on to the landfill, which would result in a 10-foot vertical cut at the property boundary. The entire slope may be cut back further into the landfill if paper residuals are found at depth.

6.2.2 EXCAVATION OF PAPER RESIDUALS ON THE ASPHALT PLANT PROPERTY

Paper residuals on the asphalt plant property will be excavated and relocated within the proposed limits shown on ~~Plan Sheet 2~~Drawing C-02, initially based on visual confirmation and finally by verification sampling as described in Section 6.2.3. The paper residuals will be placed within the landfill in lifts not exceeding 12 inches.

Based on the previous investigations, approximately 7,500 cy of visible paper residuals are estimated to be excavated and relocated back into the landfill from the asphalt plant property (~~Plan Sheet 2~~Drawing C-02). The area on the asphalt plant property requiring excavation (~~Plan Sheet 1~~Drawing C-01) is divided into two areas based on site features. The northern portion of the excavation area is in the wetland that extends north of both the asphalt property and the landfill. The southern excavation area includes a portion of the western landfill sideslope (as discussed previously), the flatter area directly west of the landfill sideslope, a paved area, and the asphalt berm area.

Northern Excavation Area on Asphalt Plant Property

In the wetland, and as documented in the predesign studies (RMT, 2008e) (copied in Appendix A of the~~is~~ RMT Pre-Final Design ~~r~~Report), where present, paper residuals are covered by approximately 6 inches of organic topsoil or a black silty sand. Paper residuals in the northern portion of the excavation area are gray, overlie peat, and are approximately 3.5 feet thick. Paper residuals are easily distinguishable from the native soil based on color and consistency.

As needed, the sidewalls of the excavation will be sloped to maintain overall stability of the excavation. The sidewalls of the excavation along the landfill will be graded to a slope of 4 horizontal to 1 vertical to maintain the stability of the excavation and the landfill. Standing water or groundwater may be encountered during excavation activities. Under these conditions, the paper residuals will be temporarily stockpiled immediately adjacent to the excavation area (and within the silt fencing), where excess water can gravity-drain back into the excavation prior to transportation to the landfill. This dewatering procedure is generally consistent with the U.S. EPA-authorized TCRA river sediment excavation activities. After transportation to the landfill, if the paper residuals are still too wet, they ~~may~~ will be spread in thin lifts and allowed to air-dry, mixed with mulch or dryer fill materials~~,~~ generated from the landfill grading activities, or mixed with solidification agents (e.g., Portland cement).

Southern Excavation Area on Asphalt Plant Property

In the southern excavation area on the asphalt plant property, and as documented in the predesign studies (RMT, 2008e) (copied in Appendix A of the~~is~~ RMT Pre-Final Design ~~r~~Report), where present, paper residuals are covered by varying amounts of granular fill and asphalt and these residuals are up to approximately 10 feet thick. Paper residuals are easily distinguishable from the fill material and asphalt based on color and consistency. A tarry material (likely asphalt) was found to be commingled with paper residuals at 4.5 feet bgs at Geoprobe® boring RDB-12, installed during the predesign studies investigation. At various depths, petroleum odors are also noted. The source of the petroleum odors ~~could~~ were not ~~be~~ identified by RMT.

As needed, the sidewalls of the excavation will be sloped to maintain overall stability of the excavation. The sidewalls of the excavation along the landfill will be graded to a slope of 4 horizontal to 1 vertical to maintain the stability of the excavation and the landfill. To the extent practical, and based on visual observation, granular fill/soil and asphalt overlying the paper residuals will be segregated from the paper residuals and stockpiled on the asphalt plant property in a nearby area to be designated by Wyoming Asphalt. Excavated paper residuals containing petroleum-based odors will be placed in the landfill (and incorporated with the paper residuals placed under the final cover).

During the predesign studies field investigation in June 2008, groundwater was encountered at a minimum of 3 feet bgs in this area. At this point in the design, whether groundwater will enter into the excavation and need to be removed from the excavation is unknown, but quite likely. Prior to the start of construction, the contractor performing the Remedial Action (RA) construction activities may elect to perform some field testing to confirm whether groundwater will be encountered and check the quality of such encountered groundwater. The RA contractor will be responsible for identifying and providing the names of a licensed transporter and disposal facility for off-site disposal in the event that water is encountered during excavation activities, and off-site disposal is needed. As applicable, the RA contractor will also be required to provide the sampling procedures that support acceptance at the disposal facility. All transportation and disposal sub-contractors will be required to meet applicable provisions of federal, state, and local regulations and codes. Once an acceptable transporter and disposal site are provided to Weyerhaeuser and within a minimum of 2 weeks prior to implementation, the proposed transporter, disposal facility, and associated sampling requirements will be provided to the U.S. EPA.

~~If on-site discharge of groundwater is appropriate, prior to the start of construction, the contractor performing the Remedial Action construction activities will be responsible for identifying and providing to Weyerhaeuser for approval, details regarding the conveyance systems to facilitate on-site discharge of groundwater. These systems will meet the requirements of federal, state, and local requirements. Once these proposed management methods are reviewed and determined to be acceptable to Weyerhaeuser, and within a minimum of 2 weeks prior to implementation of the work activities, the proposed details regarding any on-site discharge of groundwater will be provided to the U.S. EPA.~~

As an alternate to off-site disposal of water encountered during excavation activities, the RA contractor may elect to manage the water on-site. On-site water management will consist of a system, which will store, treat, and discharge to the sanitary sewer system or to the wetlands under the substantive requirements of a National Pollutant Discharge Elimination System (NPDES) permit. The water handling and on-site storage system will address the following:

i) potentially contaminated surface water;

ii) water collected from construction excavations;

iii) groundwater and surface water entering excavation areas;

iv) surface water collected from temporary soil stockpiles; and

vi) wastewater from the personnel (not including sanitary wastewater) and equipment decontamination facilities.

Water that is collected from the above-mentioned sources will be collected and pumped to a 20,000-gallon frac tank for temporary storage. The influent frac tank will settle sediment from the water, therefore the RA contractor shall take care when pumping water from the influent frac tank into the treatment system. Once a sufficient volume of water has been collected, the water will be treated using an on-site water treatment system. The on-site wastewater treatment system will consist of sand filtration followed by treatment through primary and secondary activated carbon adsorption units. The treated water will be pumped to a 20,000-gallon effluent storage frac tank. The treated effluent will be sampled by the RA contractor in the effluent storage frac tank prior to discharge. The RA contractor will provide a minimum of two 20,000-gallon effluent frac tanks so that sufficient storage capacity is available to prevent delay of the excavation activities. The design flow rate of the system will be approximately 50 gpm. The system will be provided with appropriate secondary containment.

Treated effluent will be discharged to the local sanitary sewer system or the wetland area north of the 12th Street Landfill once the treated water has been confirmed to meet the discharge requirements. The parameters for analyzing the effluent prior to discharge will be determined to ensure that the water meets the local municipality's Publicly Owned Treatment Works (POTW) pretreatment requirements or the requirements of an NPDES permit. The proposed discharge rate for the treated water will be determined based on the on-site water management option selected by the RA contractor. The rate and volume of discharges will be recorded by the RA contractor.

In the event that the surface water and groundwater cannot be treated on-Site to meet POTW or NPDES discharge requirements, the water will be sent off-site to a commercial treatment facility. Water which requires off-site disposal, will be managed in accordance with applicable regulations as discussed above.

Paper residuals excavated from below the water table ~~may~~will be temporarily stockpiled immediately adjacent to the excavation area (within the silt fencing), where the material will be allowed to dewater~~,~~ (excess water can gravity-drain back into the excavation) prior to being transported to the landfill. After being transported to the landfill, if the paper residuals are still too wet to support additional fill, they may be spread in thin lifts (not exceeding 12 inches) and allowed to air-dry, mixed with mulched materials or dryer fill materials generated from the landfill grading activities, or mixed with solidification agents (e.g., Portland cement).

Oil/Natural Gas Pipeline on Asphalt Plant Property

An underground oil/natural gas pipeline that is owned by Major Pipeline, L.L.C. (Major Pipeline)~~, that~~ but is not currently ~~not~~ in service, is present in the area where paper residuals need to be excavated (~~Plan Sheets 1 and 2~~Drawings C-01 and C-02). The Right-of-Way Agreement for this pipeline indicate~~d~~s that it was installed in approximately 1957. Based on discussions with a representative of Major Pipeline, the pipeline was installed in a trench approximately 3 to 5 feet below the then-current ground surface (which was likely in the wetland area) and backfilled with native soil. Historical aerial photographs suggest that paper residuals were placed over the backfilled pipeline. Major Pipeline will be contacted to mark the location of the pipeline in the field prior to any excavation work near the pipeline, and will be present on-Site during the start of excavation activities, at a minimum. Although the pipeline is believed to be buried a minimum of 3 feet below (not within) the paper residuals, work in the vicinity of the pipeline will proceed cautiously using hand shoveling to locate the pipe, as needed.

6.2.3 VERIFICATION SOIL SAMPLING ON THE MDNR AND THE ASPHALT PLANT PROPERTIES

Upon completion of the excavation activities on the MDNR property and the asphalt plant property to the visual extent of the distinguishable paper residuals, samples of the native soil ~~underlying the excavated paper residuals~~at the base of the excavation will be collected and analyzed to confirm the adequacy of the excavation activities. This verification sampling will be used to demonstrate completion with the Michigan Part 201 Generic Residential Cleanup Criteria (GRCC) pursuant to the MDEQ's Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria (STM; MDEQ, 2002).

Soil samples will be collected using a systematic random sampling strategy. Based on the information obtained from the test pits that were excavated on the MDNR property and asphalt plant property as part of the predesign studies conducted in 2008 (Appendix A), the estimated areal extent of paper residuals on the MDNR property is 3,~~350~~ 700 ft^2 (0.085 acre), and the estimated areal extent of paper residuals on the asphalt plant property is 31,900 ft^2 (0.7 acre). Using these estimates, and following the MDEQ's

STM guidance, it is anticipated that nine soil samples will be collected in the excavation on the MDNR property and that 13 samples will be collected in the excavation on the asphalt plant property. These estimates may be low because they do not attempt to account for the surface area of the sidewalls of the excavations. The actual number of samples to be collected on each property will be reviewed following the completion of the excavations and will be adjusted (up or down) as needed to meet the STM guidance (refer to Note 3 in Table 6-1).

Soil samples will not be collected from a local background area, as is sometimes necessary, because the constituents of potential concern, PCBs and, for the asphalt plant property, petroleum-related VOCs, would not be expected to be present at background locations.

The following text describes how the sample locations will be determined, how the samples will be collected and analyzed, and the criteria to determine if sufficient material has been excavated.

Overview of Sampling Activities - The soil samples will be collected from the top 6 inches of the native soil below the surfaces of the excavation base and sidewalls, and analyzed for PCBs. On the asphalt plant property, samples will also be tested for VOCs. At least one sample will be collected from each sidewall of an excavation. Samples will be collected following the procedures described in Section 2.5 of the Multi-Area Field Sampling Plan (Appendix N). Samples for analysis of VOCs will be collected using the field methanol preservation method.

Upon completion of ~~the~~ excavation to the visual extent of the distinguishable ~~of~~ paper residuals on the MDNR property and on the asphalt plant property, the following activities will be performed:

- Estimate the total area for which verification of soil remediation is to be performed, including the base of the excavation and the sidewalls;
- Verify that the area is similar to that estimated based on the test pit investigations performed in 2008. If the total area is more (or less) than 10 percent of the preliminary estimates shown in Table 6-1, then recalculate the grid interval and the number of samples to be collected;
- Establish a sampling grid for the total area (modifying, by hand, a sampling plan figure as necessary to represent sidewalls), using the grid intervals provided in Table 6-1. In setting up the sampling grid, identify the southwesternmost corner as the (0, 0) coordinates. Use the pre-selected coordinates of 5 feet east, 10 feet north,

(5, 10) to locate the first sampling location. Collect all remaining samples from locations that are east and north from this first location by the grid interval distance. Adjust the grid as necessary to collect at least one sample from each sidewall;

- Describe the soil samples in the field using the Unified Soil Classification System;
- Collect the samples from the top 6 inches of native soil below the surface of the excavation base and the sidewalls using a stainless-steel trowel and standard soil sampling and decontamination procedures. In addition to collecting samples for PCB analysis, collect samples on the asphalt plant property for VOC analysis using the methanol preservation method (on the asphalt plant property, collect the samples for PCB and VOC analyses at the same grid point);

  Label the samples from the MDNR property "VSRDNR-1," to denote Verification of Soil Remediation, Sample 1, through "VSRDNR-9"(estimated). Label the samples from the asphalt plant property "VSRAP-1", through "VSRAP-13" (estimated), to denote Verification of Soil Remediation (see Table 6-1);
- Place the samples in coolers containing ice, and ship the samples via overnight delivery to the laboratory following chain-of-custody procedures; and
- Analyze all samples for PCBs and, for the samples collected on the asphalt plant property (the "VSRAP" samples), analyze the samples for VOCs as well. The analytical methods and target detection limits are provided in the Multi-Area QAPP (RMT, 2008c; copied in Volume 2 of this report).

The samples will be submitted to the laboratory for quick-turn analysis (i.e., 24-hour) so that the results can be reviewed and the adequacy of the excavation verified before restoring the excavated areas. As necessary, additional excavation, followed by sample collection and analyses, may be performed.

Quality Control Samples - Collect one equipment rinsate blank and one field duplicate soil sample from each excavation (i.e., one on the MDNR property and one on the asphalt plant property). Identify the QC samples on the chain-of-custody records as QC1, QC2, etc. Record the true identify of the QC samples in the field log book. Submit the QC samples for analysis of the same parameters as the field samples.

Data Evaluation - The laboratory results will be validated to determine their acceptability in meeting the data quality objectives of the soil verification sampling program. If targeted constituents of potential concern are detected in any of the samples, use appropriate statistical methods, consistent with the MDEQ's STM guidance, to evaluate the environmental significance of any detections and the potential need to conduct additional excavation activities.

The applicable criteria are the lowest of the Part 201 GRCC in *Table 2. Soil: Residential and Commercial 1*, of the MDEQ's Remediation and Redevelopment Division's Operational Memorandum No. 1 (January 23, 2006), which are the criteria used for defining a facility under Section 324.20101(1)(o) of Part 201. For PCBs, the applicable criterion is 4 mg/kg, which is the criterion for direct contact.

Review the results of the sample analyses, and if appropriate, any statistical evaluations, with the U.S. EPA to confirm that the data quality objectives of the soil verification sampling have been met and that it is acceptable to restore the areas disturbed by the excavations.

6.2.4 RESTORATION OF DISTURBED AREAS

Once it is determined that the data quality objectives have been met on the MDNR and the asphalt plant properties, the disturbed areas will be restored to a condition agreed upon between Weyerhaeuser and the MDNR and Wyoming Asphalt, respectively. At a minimum, this will include placing fill, as needed, to promote positive drainage from the disturbed areas and the establishment of vegetation. Additional restoration activities may include the planting of trees on the MDNR property to replace trees that need to be removed as part of the excavation activities and/or restoring the paved area on the Wyoming Asphalt property that my be disturbed.

6.2.5 EXCAVATION OF PAPER RESIDUALS IN WETLAND NORTH OF THE LANDFILL

Paper residuals on the 12th Street Landfill property that are located in the wetland north of the landfill will be excavated and relocated within the proposed limits shown on ~~Plan Sheet 2~~ Drawing C-02 based on visual confirmation, in accordance with the ROD. The paper residuals will be placed within the limits of paper residuals in lifts not exceeding 12 inches. No soil verification sampling will be performed on the 12th Street Landfill property.

The following text describes the paper residuals located north of the landfill and how the area will be restored.

Extent of Planned Excavations

Approximately 4,500 cy of visible paper residuals are estimated to be excavated and relocated back into the landfill from the wetland north of the landfill in the approximate area shown on ~~Plan Sheet 2~~Drawing C-02. As documented in the predesign studies report (RMT, 2008e) (copied in Appendix A of the RMT Pre-Final Design Report), on the eastern half of the excavation areas, where present, paper residuals are visible on the ground surface, or covered by a thin (less than approximately 1 inch thick) layer of forest litter (i.e., decaying leaves and branches mixed with occasional topsoil). Paper residuals are light gray, they overlie topsoil or a poorly graded yellowish-brown sand, and they are a maximum of approximately 8 inches thick. Paper residuals are easily distinguishable from the native soil (dark-gray topsoil and yellowish-brown sand) based on color and consistency. During the predesign studies field investigation in June 2008, the groundwater was ~~approximately 1.0 to 1.5 feet bgs~~found to be at or slightly below the ground surface in this area.

The underground oil/natural gas pipeline described in Section 6.2.2 is present in the wetland where paper residuals need to be excavated (~~Plan Sheets 1 and 2~~Drawing C-01 and C-02). Historical aerial photographs suggest that paper residuals were placed over the pipeline. Major Pipeline will be contacted to mark the location of the pipeline in the field prior to work near the pipeline. Although the pipeline is believed to be buried a minimum of 3 feet below (not within) the paper residuals, work in the vicinity of the pipeline will proceed cautiously using hand-shoveling to locate the pipe, as needed.

Paper residuals in the western half of the excavation area are either at the ground surface or are covered with approximately 0.5 to 1.0 foot of organic topsoil. The paper residuals are gray, they overlie a yellowish-brown clayey organic soil or peat, and they are approximately 3 feet thick adjacent to the landfill and become thinner (less than 1/2-inch) near the limits of identified ~~limits~~ extent of visible paper residuals. Paper residuals are easily distinguishable from the native soil based on color and consistency.

The sidewalls of the excavation along the landfill will be shallow (less than 4 feet) and will be graded to a slope of 4 horizontal to 1 vertical to maintain the stability of the excavation and the landfill. Standing water and/or groundwater may be encountered during the excavation activities.

At this point in the design, whether groundwater will enter into the excavation and need to be removed from the excavation is unknown. Prior to the start of construction, the contractor performing the Remedial Action construction activities may elect to perform some field testing to confirm whether groundwater will be encountered and check the quality of such encountered groundwater. The RA contractor will be responsible for identifying and providing the names of a licensed transporter and disposal facility for off-site disposal in the vent that water is encountered during excavation activities, and off-site disposal is needed. As applicable, the RA contractor will also be required to provide the sampling procedures that support acceptance at the disposal facility. All transportation and disposal sub-contractors will be required to meet applicable provisions of federal, state, and local regulations and codes. Once an acceptable transporter and disposal site are provided to Weyerhaeuser and within a minimum of 2 weeks prior to implementation, the proposed transporter, disposal facility, and associated sampling requirements will be provided to the U.S. EPA.

~~If on-site discharge of groundwater is appropriate, prior to the start of construction, the contractor performing the Remedial Action construction activities will be responsible for identifying and providing to Weyerhaeuser for approval, details regarding the conveyance systems to facilitate on site discharge of groundwater. These systems will meet the requirements of federal, state, and local requirements. Once these proposed management methods are reviewed and determined to be acceptable to Weyerhaeuser, and within a minimum of 2 weeks prior to implementation of the work activities, the proposed details regarding any on-site discharge of groundwater will be provided to the U.S. EPA.~~
Alternatively, if on-site water management is determined to be the most viable option for water management, the water will be stored, treated, and discharged in accordance with the details provided in Section 6.2.2.

Paper residuals excavated from below the water table ~~may~~ will be temporarily stockpiled immediately adjacent to the excavation area (within the silt fencing), where the material will be allowed to dewater~~,~~ (excess water can gravity-drain back into the excavation) prior to being transported to the landfill. After being transported to the landfill, if the paper residuals are still too wet to support additional fill, they may be spread in thin lifts (not exceeding 12 inches) and allowed to air-dry, mixed with mulched materials or dryer fill materials generated from the landfill grading activities, or mixed with solidification agents (e.g., Portland cement).

Restoration of Disturbed Areas

Once the visible paper residuals are removed from the wetland north of the landfill, the area will be covered by the final cover and access road as shown on Detail 1 on ~~Plan Sheet 5~~ Drawing C-05 or restored by backfilling the excavation. The backfill material will be capable of sustaining vegetation similar to what exists adjacent to the excavation. Restored areas that are outside the proposed limits of the landfill final cover and the site access road will be revegated in accordance with the Construction Quality Assurance (CQA) Project Plan (Appendix C) and the Specifications (Appendix E).

6.3 LANDFILL GRADING

6.3.1 GRADING PLAN

As described in Section 4.3 of the~~is~~ RMT Pre-Final Design ~~r~~Report, during the Emergency Action in 2007, the entire eastern slope of the landfill along the Kalamazoo River was cut back to an approximately 5H:1V slope. A buffer zone was created along the former powerhouse channel by cutting back approximately 35 feet of the eastern slope of the landfill adjacent to the river (Figure 4-3). A clay barrier layer was also constructed along the base of the regraded eastern slope. Additional details regarding the landfill final cover are discussed in Section 6.4 of this report.

Following the removal of the visible paper residuals/sediment in the channel, the riverbank from approximately elevation 698.0 to 702.5 feet M.S.L. was regraded to a 3H:1V slope and covered by riprap (D_{50} of 9 inches), installed over a geotextile fabric. Upslope of the riprap (approximately elevation 703.0 feet M.S.L.), 6 inches of topsoil were placed across the bench (approximately 703.0 feet M.S.L.). From elevation 702.5 to 707.0 feet M.S.L. on the regraded 5H:1V sideslope, 6 inches of general fill material were placed on the eastern sideslope, overlain by 6 inches of topsoil. The topsoil was then covered by erosion control matting (Enkamat®, which is a three-dimensional nylon turf reinforcement mat made of nylon filaments joined at the intersections).

The topsoil and erosion control matting above elevation 702.5 feet M.S.L. will be removed and restored as part of the final cover placement.

The remaining sideslopes on the northern, eastern, and western sides of the landfill will be graded to a maximum of ~~4~~3H:1V. The paper residuals along the MDNR property and the asphalt plant property boundaries will be pulled back a minimum of ~~22~~12 feet from the property line to provide the space required to build an access road ~~and surface water controls~~ around the base of the landfill (Detail 1 on ~~Plan Sheet 5~~Drawing C-05).

~~An approximately 8-foot wide bench (Detail 2 on Plan Sheet 5) will be created approximately halfway up the landfill sideslope on the northern, western, eastern, and southeastern sideslopes. This bench could be used as a walking path as part of a potential future "eco-park" design, and will also minimize soil erosion caused by surface water runoff.~~ Based on the proposed grading plan (Drawing C-03), and the results from the soil borings advanced into the landfill during the recently completed predesign studies investigation~~ (copied in Appendix A of this report)~~, approximately 26,600 cy (volume to be confirmed in final design) of material will be cut from the existing landfill sideslopes and relocated further into the landfill.

The relocated paper residuals will be placed on top of the existing landfill, as ~~such that~~ the northern, western, and southeastern landfill sideslopes ~~will be graded~~ are cut back to a ~~4~~3H:1V slopes. The eastern landfill sideslope along the Kalamazoo River will ~~be graded to~~ remain at 5H:1V, while the southern sideslope along 12th Street will be graded to an 8H:1V slope.~~, and t~~The top of the landfill will be graded to a minimum 5 percent slope, as shown on Drawing C-03~~ (Plan Sheet 3)~~. The approximate fill height after regrading will be approximately ~~741~~735 feet M.S.L., which is only 2 feet higher than the current landfill and approximately 35 feet above the wetlands.

6.3.2 GLOBAL SLOPE STABILITY EVALUATION

As part of the design review and subsequent re-design of the 12th Street Landfill cover system, a geotechnical investigation was carried out between May 6 and May 12, 2009. The purpose of the geotechnical investigation was to determine the composition and shear strength of the landfill materials and the shear strength of the off-site paper sludge materials. These geotechnical parameters are required for evaluating the stability of the completed landfill slopes and the sliding stability of the proposed landfill cover. A separate memorandum presenting the details of the recently completed geotechnical investigation is included in Appendix A – Documentation of Predesign Studies.

A review of the landfill borehole logs (included with geotechnical memorandum in Appendix A) shows that the depth of the landfill deposits (paper residuals) is 22 to 29.5 feet bgs in boreholes SB-1 to SB/GW-6, with the exception of SB/GW-2 which was terminated in the landfill deposits at a depth of 36 feet bgs. At boreholes SB-1, SB/GW-2, SB-3, SB-4 and SB-5, which are generally located along the top edge of the landfill slopes, sand (SB-1 to SB-4) and/or fly ash (SB-5) materials were encountered at the ground surface or below the topsoil layer. The sand and/or fly ash materials extend to depths of 9 to 21 feet bgs and are underlain by the paper sludge or paper sludge/sand mix materials which extend to the native deposits beneath the landfill. In borehole SB/GW-6, advanced close to the center of the landfill, there was a surficial sand layer of only 2 inches thick before paper sludge materials were encountered, which continued to a depth of 25.5 feet bgs before encountering native sand deposits.

The standard penetration test (SPT) "N" values of the paper sludge materials ranged from 1 to 11 blows per foot, indicating a state of consistency ranging from very soft to stiff. The moisture content in the paper sludge and paper sludge/sand mixtures ranged from 19 to 126 percent, indicating generally saturated conditions. The undrained shear strength of the paper sludge materials was tested through field shear vain tests (FVT), which showed that the peak undrained shear strength of the paper sludge and paper sludge/sand mixtures in the landfill ranged from 516 to 3095 pounds per square foot (psf), while residual shear strengths ranging from 258 to 1290 psf. This resulted in a sensitivity of 1.2 to 3.7.

Based on the results presented in the attached technical memorandum, g~~G~~lobal slope stability modeling ~~was~~ will be performed ~~(Appendix B)~~ to assess the potential effect of the moisture content and shear strength of the paper residuals on the stability of the landfill sideslopes following the excavation and relocation of paper residuals within the landfill and to meet the requirements of the State of Michigan solid waste management regulations (Part 115). The slope stability modeling ~~was~~ will be performed for the most critical slope configuration (~~4~~3H:1V), ~~conservatively~~ assuming saturated fill conditions at a reasonable depth below the landfill surface (using the results of the recent geotechnical investigation). ~~The slope height and geometry that were modeled were based on the landfill grading plan (without the 8-foot wide bench that will be created halfway up the landfill slope to conservatively simplify the model). The results of the global slope stability modeling indicate that a factor of safety of 1.34 will be obtained for the modeled "worst-cast" conditions. This factor of safety is conservative because it does not take into account the 8-foot wide mid-slope bench, which will increase the factor of safety.~~

Michigan solid waste regulations stipulate analysis of slope stability, but do not define a required factor of safety. Generally accepted geotechnical practice applies a factor of safety of 1.5 for "normal conditions" and 1.3 for "worst-case conditions". The worst-case conditions of complete saturation are not likely to occur because of the extent and thickness of the hydraulically conductive sand fill that comprises the landfill's existing cover and its proposed final cover. The sand will act as a preferential pathway to dewater and stabilize the residuals within the landfill such that they are not likely to remain saturated. ~~The calculated factor of safety is consistent with current practice for the modeled worst-case conditions. The result also confirms that leachate does not need to be removed from the 12th Street Landfill to achieve stable sideslopes, as presented in the Documentation of the Predesign Studies report (copied in Appendix A of this report).~~

~~As described in the Documentation of the Predesign Studies report~~,Although Weyerhaeuser does not plan to install a leachate collection system at the 12th Street Landfill, perched liquid may be present within the landfill, as described in the RMT report entitled "Documentation of the Predesign Studies". Based on conclusions from previous subsurface investigations at the landfill (i.e., the Test Pit Investigation Technical Memorandum, Geraghty & Miller, 1994a), perched liquid was found in areas where high-permeable material (construction debris) overlies low-permeable material (paper residuals). ~~These areas are identified on Plan Sheet 2.~~ Test pits will be excavated in these areas, and if present, perched leachate will be removed. Leachate seeps may also form, during the regrading of the landfill, in areas where perched leachate comes closer to the landfill surface. Leachate, if present, will be collected and containerized in five tanks and disposed at a licensed publicly-owned treatment works (POTW) or managed on-site as discussed in Section 6.2.2.

6.4 FINAL LANDFILL COVER SYSTEM

To meet the requirements of the ROD (described in Section 4.2 of the~~is~~ original RMT report), a final cover system will be placed over the regraded landfill sideslopes and top portion of the landfill.~~will be covered by a sidewall containment system (SWCS) (also known as a final cover system)~~ The final cover ~~that~~ has been designed to meet the following objectives:

- to prevent the release of PCBs to the environment;
- to provide sideslope stability, flood protection, and erosion control;
- to minimize infiltration of precipitation through the landfill;
- to prevent migration of residuals or leachate from the landfill into the adjacent areas; and
- to eliminate direct contact hazards.

The final cover ~~has also been~~ will be designed to meet the relevant portions of the Michigan Solid Waste Landfill closure regulations pursuant to Part 115, Solid Waste Management, of the NREPA. The erosion protection provided will be sufficient to protect the containment system from a 500-year flood event.

Prior to constructing the final cover over the 5H:1V eastern sideslope, the existing 6-inch thick layer of topsoil along with the turf reinforcement mat (Enkamat®) that was installed during the Emergency Action in 2007, will be removed. The topsoil and Enkamat® were installed as an interim measure until the final cover was constructed.

The riprap and the clay barrier layer ~~(Figure 4-3)~~ installed during the Emergency Action in 2007 will remain in place. As described in the Emergency Response Plan Design report (RMT, 2007a), the riprap and the clay barrier layer are permanent measures that will not be removed during the Remedial Action. Installation of these measures as part of the Emergency Action will allow for the rest of the final cover system to be installed above the elevation of the 2-year flood event (approximately 702.5 feet M.S.L.).

~~The clay barrier layer is part of the final cover system that will provide sidewall containment and hydraulic separation.~~

The final cover will be installed over approximately 6.8 acres of the 12th Street Landfill (~~Plan Sheet 4~~Drawing C-04) and will consist of the following components from bottom to top (Detail 6 on ~~Plan Sheet 6~~Drawing C-06):

- A ~~6-inch select granular fill layer placed on top of the landfill as a suitable subgrade material for the final cover and a~~ gas venting layer for the passive gas venting system consisting of geocomposite drainage material (geonet) installed either as a continuous layer over the entire landfill or in strategic locations (i.e., strips of geonet) designed to convey landfill gas ~~. This layer will be capable of collecting landfill gas and conveying it~~ to the passive venting system. ~~Granular fill from an off-site source that has~~ The geonet consists of a plastic grid core with capacity for a minimum hydraulic conductivity of 1 x 10^{-2} centimeters per second (cm/s)~~, and that does not contain gravel, retained on the Number 4 sieve (for protection of the 40-mil linear low-density polyethylene [LLDPE] geomembrane above) will be used to construct the fill layer. The perforated gas pipes within this fill layer will be bedded in select aggregate fill (gravel). A 12-ounce~~ , surrounded by two layers of nonwoven geotextile to prevent soil intrusion and ~~will be placed over the select aggregate fill bedding~~ to protect the overlying geomembrane.
- A 40-mil thick textured LLDPE geomembrane liner (barrier layer) will be placed over the ~~select granular fill~~ geonet or the nonwoven geotextile fabric~~above the select aggregate fill gas pipe bedding material~~. The geomembrane liner will act as a barrier to minimize infiltration of precipitation into the residuals.

  In lieu of the PVC liner specified in the ROD, use of the 40-mil thick textured LLDPE geomembrane was previously proposed, and preliminarily accepted by the U.S. EPA (U.S. EPA 2008b). LLDPE meets the relevant portions of the Michigan solid waste management closure regulations pursuant to Part 115 and has a hydraulic conductivity on the order of 4.0 x 10^{-13} cm/s (Giroud and Bonaparte, 1989; as presented in U.S. EPA, 1994). In comparison, the hydraulic conductivity of PVC is on the order of 2.0 x 10^{-11} cm/s. ~~Moreover, LLDPE was approved for the King Highway Landfill (OU-3).~~

Because PVC geomembrane is only manufactured as a "smooth" material, it does not develop a high interface friction range or adhesion with soil or other synthetic materials (e.g., nonwoven geotextile). This makes it difficult to create stable final slopes at the proposed ~~4~~3H:1V ~~and~~ to 5H:1V grades. Because an LLDPE geomembrane can be manufactured as a "textured" material, it is a more appropriate alternative for the steep sideslopes of the 12th Street Landfill. Using a textured LLDPE geomembrane will improve the interface friction angle and the adhesion between the geomembrane and the soil or synthetic material, while still providing an effective barrier to infiltration. This will increase the factor of safety against slippage along the liner/soil interfaces and ultimately provide more stable final cover slopes.

As part of the pre-design geotechnical investigation, direct shear box testing will be performed to ~~Calculations were performed (Appendix B) to~~ determine the factor of safety against slippage along the critical geosynthetic (geomembrane/soil, geomembrane/geotextile, and geotextile/soil) and soil interfaces. ~~Typical engineering values and direct shear test results from previous final cover construction projects at other landfills were used in the calculations. Although the~~ The shear box testing will utilize ~~site~~ specific soil and geosynthetic materials that would be used for the 12th Street Landfill remedial action ~~have not yet been identified, and thus tested, available test results from previous final cover construction projects and typical engineering values generally~~ to represent the critical interfaces within the 12th Street Landfill final cover system. The resultant calculations ~~indicate that minimum factors of safety of 2.03 and 1.31 will be obtained for the geosynthetic and soil interfaces, respectively, identified~~ would determine the factors of safety above on the ~~4~~3H:1V landfill sideslopes for the modeled "worst-case" conditions. These factors of safety ~~are above the~~for generally accepted geotechnical practice ~~of applying a factor of safety of~~ are 1.5 for "normal conditions" and 1.3 for "worst-case conditions".

Direct shear testing will be performed prior to construction to determine site-specific values for the ~~sand/sand, sand~~paper sludge/geocomposite drainage net, paper sludge/40-mil LLDPE textured geomembrane, geocomposite drainage net/40-mil LLDPE textured geomembrane, 40-mil LLDPE textured geomembrane/12-ounce nonwoven geotextile, and the 12-ounce non-woven geotextile/select aggregate fill interfaces. ~~Updated i~~The resultant interface slope stability calculations incorporating the~~se~~ direct shear box testing results will be submited to the U.S. EPA ~~prior to construction~~.

- A 12-inch thick select granular fill layer (part of the required 24-inch thick protective layer) will be placed above the 40-mil thick textured LLDPE geomembrane liner.

(The liner will be overlain by 12-ounce non-woven geotextile to protect the liner against punctures). Granular fill will be obtained from an off-site source that has a minimum hydraulic conductivity of 1×10^{-2} cm/s, and that does not contain gravel retained on the Number 4 sieve (for protection of the 40 mil LLDPE geomembrane below). This layer will act as a subsurface drainage layer to convey infiltrating surface water off of the final cover.

Alternatively, a geocomposite drainage material (geonet) may be used in lieu of the 12-inch thick select granular fill layer. A geonet can typically convey infiltrating surface water off of the final cover system more effectively than aggregate material. Also, a geonet comes with geotextile fabric surrounding the plastic grid core, so a separate geotextile fabric would not be required. The contractor will be allowed to install either the 12-inch thick select granular fill layer (with separate geotextile) or the alternative geonet. (Note that the use of geonet must also include an additional 12 inches of general fill to achieve the required 24-inch thick protective layer if a geonet is used for the drainage layer).

- A 12-inch (or 24-inch) thick general fill layer (part of the required 24-inch thick protective layer) will be placed above the 12-inch thick select granular fill layer (or geonet). This protective layer will be capable of sustaining the growth of nonwoody plants and will have adequate water-holding capacity.
- A 6-inch thick vegetative layer will be placed over the protective layer. This layer will be designed to promote vegetative growth, promote surface water runoff, and minimize erosion. Consistent with the future use of the land being an eco-park, the vegetative growth will consist of a mix of grasses and forbes (flowering plants) native to the area.

The final cover components describe above will be placed in accordance with the requirements of the Construction Quality Assurance (CQA) Project Plan (Appendix C) and the Specifications (Appendix E).

The final cover along the Kalamazoo River will tie into the clay barrier layer, as shown on Detail 2 on ~~Plan Street 6~~Drawing C-06~~. The existing clay barrier will be extended approximately 30 feet to the north during the Remedial Action (Plan Sheet 4) to provide hydraulic separation between the proposed limits of paper residuals and the Kalamazoo River~~. The portion of the clay barrier layer that is disturbed as a result of tying the geomembrane barrier layer into the clay barrier layer, will be reconstructed and tested in accordance with the CQA Project Plan (Appendix C) and the Specifications (Appendix E). Prior to the connection of the final cover to the clay barrier layer along the Kalamazoo River, the portion of the north slope extending beyond the north limit of the previously constructed 5H:1V eastern sideslope (part of Emergency Action in 2007) will be relocated back on to the 12th Street Landfill during the other off-site material (paper residuals) relocation activities.

As shown in Appendix F, the riprap was designed to provide protection from the flow velocity (5.7 feet per second) of the 500-year flood event. Previously, approximately 260 linear feet of riprap were installed along the Kalamazoo River as part of the Emergency Response Action performed in 2007. The riprap was installed over a geotextile fabric from the base of the river up to elevation 703.5 feet M.S.L. (the elevation of the access road along the riverfront is 703 feet M.S.L.)~~. An additional 50 feet of riprap will be installed (20 feet beyond the clay) to provide the necessary protection of the proposed landfill footprint. The riprap will be placed in accordance with the requirements of the CQA Project Plan (Appendix C) and the Specifications (Appendix E)~~.

Upslope of the riprap, for the entire length of the proposed eastern landfill sideslope ~~(and extended 20 feet beyond the northern edges of the slope)~~, erosion control matting (Enkamat®, which is a three-dimensional nylon turf reinforcement mat made of nylon filaments joined at the intersections) will be installed from approximate elevation 703 feet M.S.L. to approximately 707 feet M.S.L. (~~Plan Sheet 4~~ Drawing C-04 and Detail 2 on Drawing C-06~~Plan Sheet 6~~). Calculations contained in Appendix F show that the Enkamat® installed to an elevation of approximately 707 feet M.S.L. will meet the requirements of the ROD, which requires an erosion protection system to provide protection from a 500-year flood event and extend to a minimum elevation of 707.0 feet M.S.L. In addition, the transition area between the 12th Street Landfill property and the MDNR property (on the southern end of the eastern side of the 12th Street Landfill along the Kalamazoo River will be protected by erosion control matting.

6.5 SURFACE WATER MANAGEMENT

Temporary erosion and sedimentation controls will be installed prior to excavation and landfill grading activities and will be maintained until permanent erosion controls are in place. Temporary erosion and sedimentation controls will consist of silt fencing. Silt fences will be installed around the proposed excavation areas (~~Plan Sheet 2~~Drawing C-02) to prevent the potential migration of sediment from the limits of construction as a result of surface water runoff. Silt fences will be visually inspected in accordance with Section 7.2. Trapped sediment will be excavated and placed into the landfill underneath the final cover. Sediment controls will be installed in accordance with the Specifications (Appendix E) and with the Guidebook of Best Management Practices for Michigan Watersheds (MDEQ, 1998).

In addition to the ~~permanent~~ erosion protection along the eastern landfill sideslope (riprap and Enkamat®) described previously in Section 6.3, erosion caused by surface water runoff from the rest of the landfill final cover will be minimized by vegetating the final grades ~~and installing a bench approximately halfway up the slope along the western, northern, and southeastern landfill sideslopes~~. Estimates of erosion from the landfill, using the Revised Universal Soil Loss Equation, are presented in Appendix G.

~~Surface water runoff from above the mid-slope bench will be collected in a series of perforated collection pipes located within the final cover (Detail 2 on Plan Sheet 5) and directed to downslope flumes (Details 3 and 4 on Plan Sheet 5) that discharge into the on-site wetland or to an outlet adjacent to the Kalamazoo River (Plan Sheet 4).~~ Surface water runoff on the west side of the landfill ~~from below the bench~~ will be ~~collected by~~ directed alongside the access road ~~(the access road is designed such that it can collect and convey surface water runoff)~~ through a shallow ditch that ~~and~~ discharges into the on-site wetland to the north~~or into the Kalamazoo River~~. On the southern landfill slope, surface water will be diverted to the east ~~access roads using diversion berms~~ through a shallow ditch that discharges to the MDNR property(~~Plan Sheet 4~~ Drawing C-04 and Detail 4 on ~~Plan Sheet 8~~Drawing C-08)~~ and culverts underneath the midslope bench (Plan Sheet 4 and Detail 3 on Plan Sheet 8)~~. For the remainder of the site, surface water will be allowed to sheet flow off the cover system and into the wetlands to the north or the adjacent properties. Perforated toe drain pipes will be installed at the base of the final cover (and within the 12-inch thick granular fill layer or connected to the geonet that is part of the final cover) to drain any surface water that may infiltrate into the final cover soil. The perforated toe drain pipe will have discharge points approximately every 200 feet (Detail 1 on ~~Plan Sheet 5~~Drawing C-05). As a result of the subsurface water controls and some diversion of surface water via shallow ditches, ~~T~~the flow rate of surface water that may discharge onto the adjacent MDNR property or asphalt plant property (after the final cover is installed) will be less than under current conditions.

Analysis of the surface water management system (Appendix G) was completed using a 25-year, 24-hour storm event, and the U.S. Department of Agriculture Soil Conservation Service's (now known as the Natural Resource Conservation Service's) Technical Release 55 (TR-55) method. The TR-55 method is a process that involves determining the drainage area, vegetative cover type, soil type, drainage path, time of concentration, travel time, rainfall amounts, storm distributions and storm durations to compute runoff quantities for each watershed.

Pipe strength analyses were performed to demonstrate that the proposed surface water collection pipes (toe drain system) for the 12th Street Landfill will withstand the potential worst-case loading conditions from soil overburden and equipment traffic (Appendix H). Piping and permeability calculations were also performed (Appendix I) to demonstrate that the ~~storm water~~toe drain collection pipes will be designed to limit pipe bedding material from entering the pipe.

6.6 LANDFILL GAS MANAGEMENT

6.6.1 GAS SYSTEM

~~As described in the RD Workplan (RMT, 2008a) and the Documentation of the Predesign Studies report (RMT, 2008e) (Appendix A of this report), based on experience at other landfills containing paper residuals, Weyerhaeuser has decided to install the components of a system to, if necessary, prevent off-site gas migration from the landfill and to protect the integrity of the final cover. The components of the system will be installed according to the CQA Project Plan (Appendix C) and the Specifications (Appendix E) and will consist of the following:~~

- ~~Approximately 3,000 linear feet of 4-inch diameter horizontal perforated high-density polyethylene (HDPE) (SDR 17) pipe (Plan Street 3 and Detail 4 on Plan Sheet 5) embedded in the 6-inch thick granular fill layer in the final cover system. As described in Section 6.3, the granular fill layer will have a minimum hydraulic conductivity of 1 x 10-2 centimeters per second (cm/s). The perforated pipe will be interconnected and will convey the landfill gas to the gas vent pipe locations.~~
- ~~Twenty 4-inch diameter HDPE (SDR 17) vertical pipes (Detail 5 on Plan Sheet 6) that extend from the horizontal perforated lateral pipes to approximately 6 inches above the surface of the final cover, at which point a blind flange will be installed in the vent a passive gas vent is necessary.~~

~~The locations of the 4-inch diameter horizontal perforated lateral pipes and the vertical gas vent locations are shown on Plan Sheet 3. Initially, the vent locations will be blinded off and monitored. The gas probes will also be monitored. If no off-site gas migration is detected, the vent locations will remain closed. If gas migration occurs, some or all of the vents will be installed.~~

~~The gas vent locations will be a minimum of approximately 24 feet from the mid-slope bench that may be used as a walking path in a future eco-park. (Potential risks to human health and safety associated with a future eco-park on the landfill, including potential inhalation of landfill gas by persons using the mid-slope walking path, will be~~

~~evaluated as part of a potential future use risk assessment that would be developed and submitted to the U.S. EPA after approximately 1 year of post-construction environment monitoring). LLDPE pipe boots will be installed around the vertical gas vent pipes to minimize gas from migrating around the pipes, and to reduce the potential for surface water infiltrating the final cover (Detail 3 on Plan Sheet 6).~~

As part of the pre-design activities, a field program will be implemented to obtain direct information regarding the ability of the 12th Street Landfill to produce landfill gas (LFG) in its current condition. The results of this field testing program will be the primary factor in the design of the gas collection system for the site. A modified Tier 3 testing program (based on U.S. EPA's Method 2E) will be implemented to obtain site-specific information regarding potential LFG generation as well as gas quality (i.e., percent methane, carbon dioxide, and oxygen). This information will assist in the confirmation of the anticipated passive LFG collection system design, as outlined below.

A passive LFG collection system will be designed for the 12th Street Landfill to mitigate the potential buildup of gas under the final cover system. The system will be designed to include strips of gas collection media installed perpendicular to the slopes, connecting nay collected gas at the toe of slopes to the passive gas vents installed in the top area of the site. These strips may consist of geocomposite drainage material lain over the existing paper sludge residuals or the excavation of shallow gravel trenches within the surface of the waste. The offset distance or placement of the strips/trenches will be supported by information obtained from the field testing program to estimate the LFG generation rate for this particular Site. It is currently anticipated that the strips/trenches may be installed at approximately 200-foot centers, perpendicular to the slopes. (If trenches are utilized in lieu of geonet strips, the trenches will be installed approximately 2 feet into the waste, with a 4-inch polyvinyl chloride (PVC) schedule 40 pipe in each trench that is connected to a vent near the top of the landfill that penetrates through the final cover liner system). The final horizontal spacing design for the strips/trenches will increase or decrease pending the results of the planned field investigation activities. The anticipated vent spacing for this Site is approximately one per acre.

The potential pressures developed from the production of LFG (based on the testing results) will be incorporated into the planned passive venting system as well as the stability determination of the final cover system. The final design will incorporate a potential LFG pressure of approximately 10 to 20 inches of water column (in. WC) for 3H:1V slopes, which is consistent with values found in literature (RG&A, 2008) (should 4H:1V slopes be required, the potential LFG pressures would be between 17 and 28 in. WC). The range of values presented is dependent on the adhesion of the materials being used in the cover design.

Pipe strength calculations ~~were~~ will be performed to demonstrate that the horizontal ~~HDPE (SDR 17)~~gas collection pipes (if gravel trenches are utilized) ~~pipes~~ will withstand the potential worst-case loading conditions from soil overburden and equipment traffic ~~(Appendix H)~~. Piping and permeability calculations ~~were~~ will also be performed ~~(Appendix I)~~ to determine the appropriate size perforations to limit pipe bedding material from entering the pipe.

The passive gas vent locations will be monitored in accordance with the PSVP (Appendix D). ~~Depending on the results from the landfill gas monitoring activities (see Appendix D), some or all of the gas vents may be installed as described above. If the results from the landfill gas monitoring program indicate the need to actively collect landfill gas in some or all areas of the landfill (if for example, methane is detected at elevated concentrations in perimeter monitoring probes), an active landfill gas system will be designed and installed.~~ Any modifications to the gas management system will be presented to the U.S. EPA for review and approval prior to implementation.

6.6.2 PERIMETER LANDFILL GAS MONITORING NETWORK

Natural features, including the wetlands and the Kalamazoo River, limit potential landfill gas migration pathways to the north and east of the landfill, respectively. Following the construction of the final cover, gas monitoring probes will be installed along the southern side of the landfill property, along the boundaries with the MDNR property and 12th Street, and along the boundaries with the asphalt plant property to the west. The probes will be spaced approximately every 250 feet at the locations shown on ~~Plan Sheet 4~~Drawing C-04. A typical gas probe construction detail is shown in Detail 5 on ~~Plan Sheet 7~~Drawing C-07. The landfill gas monitoring probes will be monitored in accordance with the O&M Plan (Appendix J) and the PSVP (Appendix D), both contained in the RMT Pre-Final Design Report.

6.7 ACCESS ROAD

An approximate 10-foot wide access road will be constructed around the much of the perimeter of the landfill and will be accessible from 12th Street (~~Plan Sheet 4~~Drawing C-04). The only location around the perimeter of the landfill that may not have an access road is along the north side of the MDNR property, due to the encroachment of the existing slope on MDNR property. Construction of an access road along this portion of the landfill boundary would require even further cuts into the existing slope than are already required to pull all waste paper residuals back on-site.

The access road will effectively be an extension of the cover system (topsoil and general fill) and will be constructed in accordance with the CQA Project Plan (Appendix C) and the Specifications (Appendix E), both contained in the RMT Pre-Final Design Report, and will be installed at a minimum elevation of 703 feet M.S.L. to allow for access during a 2-year flood event (702.5 feet M.S.L.). Along the western, northern, and southeastern sides of the landfill, the access road will be constructed of general fill (base) and ~~select aggregate fill~~ topsoil (Detail 1 on ~~Plan Sheet 5~~Drawing C-05). The access road will typically only be used for monitoring activities, so access will be limited to all-terrain vehicles only. Along the Kalamazoo River on the eastern side of the landfill, the access road will ~~consist~~ continue as~~of~~ topsoil, plus ~~and~~ Enkamat® (Detail 2 on ~~Plan Sheet 6~~Drawing C-06), in order to provide a more aesthetic view from the river and from the walking paths in the potential future eco-park.

–The access road will be widened approximately 3 feet at certain locations (Detail 2 on ~~Plan Sheet 8~~Drawing C-08) to allow for the installation of, and access to, gas probes and groundwater monitoring wells. Gates (Details 3 and 4 on ~~Plan Sheet 7~~Drawing C-07), designed to prevent vehicle access, will be installed at the access road entrance~~s~~ along 12th Street. Additional information regarding the gates is discussed in Section 6.8.2.

6.8 INSTITUTIONAL CONTROLS

6.8.1 DEED RESTRICTIONS

The ROD requires that deed restrictions be imposed on the 12th Street Landfill property as necessary to appropriately restrict future land use pursuant to Section 20120a (1)(i) of the NREPA (i.e., for "limited industrial" land use). The SOW states that Weyerhaeuser is to rely upon the Restrictive Covenant for the 12th Street Landfill property that was filed on April 23, 2004, and that, if any deed restrictions are needed on adjacent properties, Weyerhaeuser shall attempt to obtain such deed restrictions in accordance with Section IX of the Consent Decree. Although the SOW states that the Restrictive Covenant for the 12th Street Landfill was filed on April 23, 2004, the *Declaration of Restrictive Covenants and Environmental Protection Easement* was found to have been recorded by the Allegan County Registrar of Deeds on March 25, 2005. This document is included in Appendix K.

The March 25, 2005, *Declaration of Restrictive Covenants and Environmental Protection Easement* (Deed Restrictions) granted certain land use or resource use restrictions for the 12th Street Landfill property. These Deed Restrictions were granted by and between Plainwell, Inc., the MDEQ; and the U.S. EPA as a third-party beneficiary. Weyerhaeuser Company, as a subsequent title holder of the property, is subject to the requirements of the Owner in the Deed Restrictions.

In general, the Deed Restrictions prohibit uses of the property that are not compatible with the property's zoned industrial land use designation, the limited industrial land use category under Section 20120a(1)(i) of the NREPA, or other use that is consistent with the assumptions and basis for the cleanup criteria developed pursuant to Section 20120a(1)(i) of the NREPA. Specifically, the Deed Restrictions prohibit the following uses of the landfill property:

a) A residence, including any mobile home or factory-built housing, constructed or installed for use as residential human habitation;

b) A hospital for humans;

c) A public or private school for persons under 21 years of age;

d) A daycare center for children;

e) Any purpose involving residential occupancy on a 24-hour basis; and

f) Any other use that would disturb or penetrate the landfill cover or erosion control system as set forth in the ROD.

The Deed Restrictions also prohibit the following activities on the landfill property:

– Any excavation, drilling, penetration, or other disturbance of the surface or subsurface soil on the property, except as necessary for compliance with the O&M Plan, or conducted in accordance with any work plan approved or modified by the U.S. EPA, with MDEQ concurrence;
– Any construction of building on the property unless plans are submitted to, and approved by, the MDEQ and the U.S. EPA; and
– Any activity that may interfere with any element of the ROD, including the performance of the operation and maintenance activities, monitoring or other measures necessary to ensure the effectiveness and integrity of the remedy.

The Deed Restrictions also require that vegetation and other materials be kept clear of the permanent markers, and that all soil, media, and debris on the property be managed in accordance with the applicable requirements of Section 20120c of the NREPA; Part 111, *Hazardous Waste Management*, of the NREPA; Subtitle C of the RCRA; and other relevant state and federal laws.

As discussed in Section 2.3 of the~~is~~ RMT Pre-Final Design ~~r~~Report, following implementation of the remedial action, Weyerhaeuser is considering the development of an education-based natural park area on the 12th Street Landfill property. This educational "eco-park" would showcase the history of the Kalamazoo River in that area and highlight the adjacent wetland habitat. In concept, the eco-park may include walking paths on the landfill cover with signs at designated viewing areas that would describe the history and ecology of the area. Another potential future land use option being considered is to provide access to the township to extend a river walk along the eastern boundary of the landfill heading north through the 17 acres of wetland buffer that would connect the existing river walks in the cities of Plainwell and Otsego.

While no decisions have been made regarding the future use of the landfill, components of the remedy have been designed with the flexibility to accommodate possible future use of the property as an eco-park and/or to connect the existing Plainwell and Otsego River walks in front of the landfill.~~ As described in Section 6.2 of this Design report, the grading plan for the landfill has been designed with an 8-foot wide bench that could be used as a walking path in the future (Detail 2 on Plan Sheet 5). This walking path would be located approximately halfway up the landfill sideslopes and would provide overlooks of the river and wetlands, possibly with educational signage at select locations. In addition, the locations of the passive gas vents were selected, in part, to provide separation from the mid-slope bench so that potential odors emanating from the vents would not be a nuisance to recreational users.~~

Any future recreational use of the 12th Street Landfill property would be implemented only upon the U.S. EPA's approval, including appropriate modifications to the existing Deed Restrictions and possibly the ROD. Within the RD/RA process, the approximately 1 year into the O&M period, Weyerhaeuser may prepare a more detailed future land use concept and relevant human health risk assessment for presentation to the U.S. EPA; the MDEQ; and potential project stakeholders such as the MDNR, the cities of Plainwell and Otsego, and the U.S. Fish and Wildlife Service. The input of the stakeholder group would be incorporated into a final land use plan for review and approval by the U.S. EPA.

6.8.2 FENCING AND GATES

Fencing and gates (Details 3, 4, and 6 on ~~Plan Sheet 7~~Drawing C-07) will be installed along 12th Street (~~Plan Sheet 4~~Drawing C-04) and along ~~certain~~ a short portion~~s~~ of the asphalt property and MDNR property boundaries to deter pedestrians and vehicular traffic from entering the landfill by simply going around the ends of the fence. The fencing and gates are consistent with existing access restrictions and likely restrictions that would be needed for a potential eco-park. If the U.S. EPA and/or Weyerhaeuser determines that an eco-park is not an appropriate land use for the landfill property, Weyerhaeuser will submit a plan to the U.S. EPA to install additional fencing consistent with the ROD.

In accordance with the ROD, permanent markers will be placed along the property boundaries describing the area of the OU-4 and the nature of any restrictions. Warning signs will also be posted on the fence every 200 feet and on all entry gates. The number, content, and location of the permanent markers and warning signs will be presented to the U.S. EPA for approval prior to their installation.

6.9 PRELIMINARY CONSTRUCTION HEALTH AND SAFETY PLAN

A Preliminary Construction Health and Safety Plan (HSP) has been developed to protect field personnel and authorized site visitors during execution of the remedial action (Appendix L). The HSP has been prepared in fulfillment of the requirements that are contained in the CD and the SOW. A new HSP was submitted by Conestoga-Rovers & Associates (CRA) under separate cover on May 20, 2009 to address the RA construction activities and RI activities at Plainwell Mill. This HSP will be revised as needed to remain current with anticipated activities at both sites. ~~After the U.S. EPA's approval of the remedial design, and prior to implementing the remedial action construction activities, a final construction health and safety plan will be prepared and may be submitted to the U.S. EPA. A separate health and safety plan, specific to the O&M activities, is included in Appendix J.~~

6.10 EQUIPMENT DECONTAMINATION

Decontamination of equipment utilized during the remedial action will be performed at a decontamination pad constructed near the site entrance (refer to Section 6.1.3 of the FSP [RMT, 2008d]; copies in Appendix N of the~~is~~ RMT Pre-Final Design ~~r~~Report for additional information regarding the construction of the decontamination pad).

Decontamination water will be collected and containerized ~~in 55-gallon barrels that will be properly labeled~~ and temporarily stored on-site as discussed in Section 6.2.2. ~~Following completion of the construction activities, a sample of the decontamination water will be collected and tested for parameters required by a permitted offsite disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in report documenting the remedial action construction.~~

PRELIMINARY DESIGN CALCULATIONS

- CAP DRAINAGE LAYER HYDRAULICS
- ANNUAL SOIL LOSS FROM FINAL COVER

ENGINEERING DESIGN CALCULATION

PROJECT IDENTIFICATION

Client: Weyerhaeuser Company 56393

Project: 12 ST Landfill Location: Otsego Township, Michigan

CALCULATION IDENTIFICATION

Calculation Ref. No.: No. Pages: 13
(Including calculation cover sheet)

Calculation Description:

CAP DRAINAGE LAYER HYDRAULICS

Design: A.Wesolowski Date: May 26/09

Checked: B.Polan Date:

RECORD OF REVISION

Revision No.	Revision Date	Design	Checked	Supervised	Project Control	Detail of Revision
0	--	--	--	--	--	Original (per above)

CRA

PROJECT NO:56393 **DESIGNED BY: A.W.**

PROJECT NAME: 12 ST Landfill **CHECKED BY: B.P.**

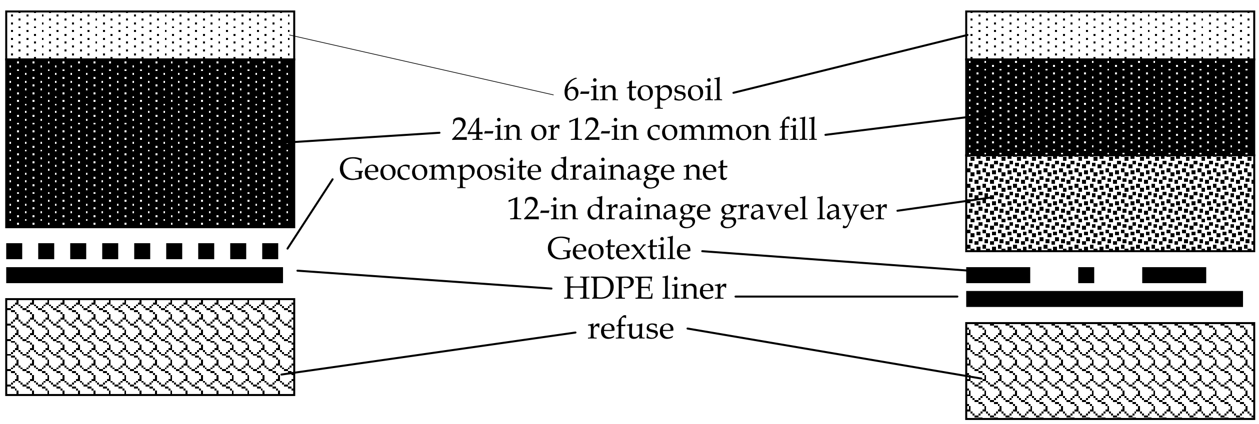
DATE : May 26/09

DRAINAGE LAYER HYDRAULICS

1. GEOCOMPOSITE DRAINAGE NET HYDRAULICS

1.1 Data input

-cap design options:



- soil layer permeability: ks = 0.00001 cm/s (1×10^{-7} m/s)
- drainage gravel layer permeability: kg = 0.001 m/s
- critical path No. 2, slope segment 5% - slope length 320 ft = 98 m
- critical path No. 2, slope segment 20% - slope length 70 ft = 21 m
- reduction factors for drainage composite
  - for intrusion RF_{in} = 1.5
  - for creep RF_{cr} = 1.4
  - for chemical clogging RF_{cc} = 1.2
  - for biological clogging RF_{bc} = 1.6
  - overall FS = 2
  - Total Fs = 8
- criteria for Lateral Drainage for Final Cover Side Slope, Landfill Drainage System www.landfilldesign.com, Unit Gradient Method. Interactive Design Tool(see attached)

1.2 Geocomposite Drainage Net Option

1.2.1 Required transmissivity of the geocomposite Y_{req}

Required (ultimate) geocomposite transmissivities have been calculated utilizing software program , Unit Gradient Method, (see attached).

Treq = 0.00158 m2/s – for 5% segment

Treq = 0.000489 m2/s – for 20% segment

1.2.2 Available transmissivity of the geocomposite Y_{avail}

Available transmissivity for GSE Fabrinet 300 mil (2x6oz) geocomposite product, according to attached manufacturers charts for given (design) gradients and normal pressure of approximately 1000 psf at given cap design configuration.

T 5% avail = 0.0033 m2/s for 5% segment
T 20% avail = 0.0018 m2/s for 20% segment

1.2.3 Method of calculation

a) Utilizing software program, the required (ultimate) transmissivitiy is below the available transmissivity (Tr_{eq}<T_{avail}).

b) Manual check utilizing total inflow into the drainage net from both segments as follows:

Total inflow into the drainage net equal to drainage net outflow:

Q IN = Q Outflow

where:

QIN for 5% segment based on 98 m length
QIN for 20% segment based on 98 m + 21 m = 119 m, total length

Q Outflow = T x i (in terms of transmissivity) for

-unit width of the drainage net = 1
- unit gradient = 1

T- required transmissivity
i – slope = 5% or 20%

QIN 5% segment = ks x L = 0.0000001 m/s x 98 m = 0.0000098 m3/s
QIN 20% segment = ks x L = 0.0000001 m/s x 119 m = 0.0000119 m3/s

Utilizing total factor of safety Fs = 8

8 x Q IN = Q Outflow

8 x QIN = T x i

T for 5% segment= 0.00157 m2/s
T for 20% segment = 0.000476 m2/s

Required transmissivity is below the available transmissivity.

1.2.4 Conclusion

The available transmissivity of GSE Fabrinet 300 mil product with 2 x 6 oz or 2 x 8 oz geotextile is satisfactory.

1.3 Drainage Gravel Layer Option

1.3.1 Infiltration into drainage layer

QIN 5% segment = ks x L = 0.0000001 m/s x 98 m = 0.0000098 m3/s
QIN 20% segment = ks x L = 0.0000001 m/s x 119 m = 0.0000119 m3/s

Per 1 meter width and unit gradient = 1

1.3.2 Available drainage gravel layer hydraulic capacity

Qavail 5% segment = kg x i x A = 0.001 m/s x 0.05 x (0.30 m x 1.0 m) = 0.000015 m3/s

Qavail 20% segment = kg x i x A = 0.001 m/s x 0.20 x (0.30 m x 1.0 m) = 0.000060 m3/s

1.3.3 Conclusion

The available drainage gravel layer hydraulic capacity , based on kg= 0.001 m/s material permeability is satisfactory.

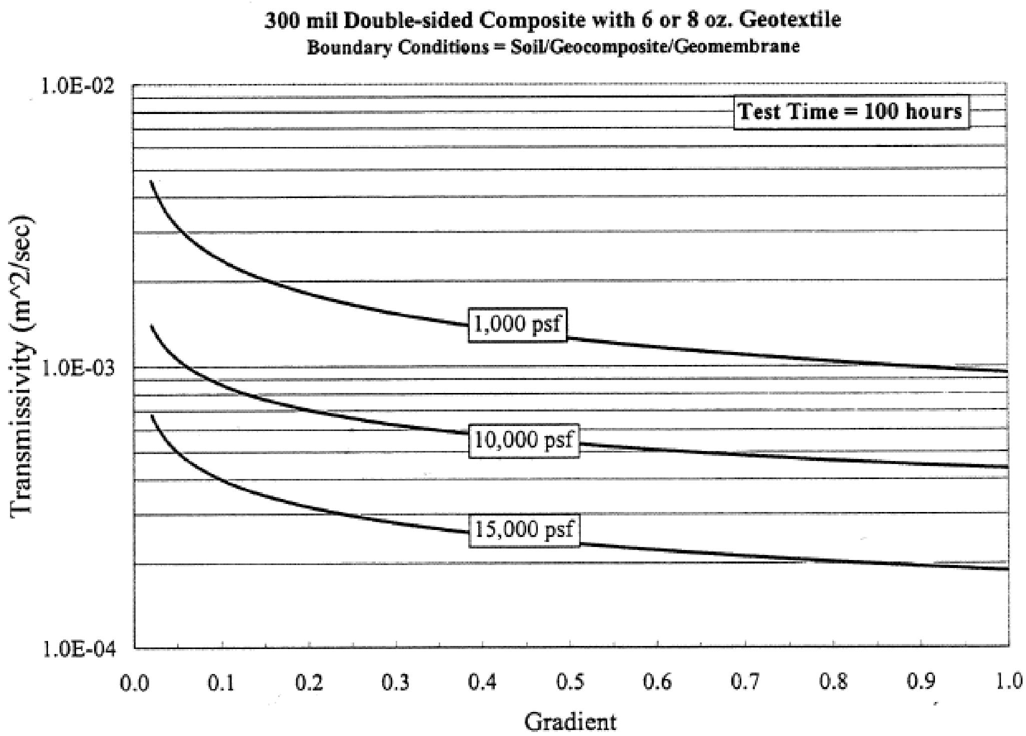


Figure A-9 100-hour transmissivity of 300 mil biplanar geonet geocomposite under soil/geocomposite/geomembrane boundary conditions.

GSE STANDARD PRODUCTS

Product Data Sheet

GSE FabriNet UF Geocomposites

GSE FabriNet UF geocomposite consists of GSE HyperNet UF geonet heat-laminated on one or both sides with a GSE nonwoven needlepunched geotextile. GSE HyperNet UF is a 300 mil thick geonet manufactured from a premium grade high density polyethylene resin. For the purpose of lamination to geonets, GSE nonwoven needlepunched geotextiles are available in mass per unit area range of 6 oz/yd^2 (200 g/m^2) to 16 oz/yd^2 (540 g/m^2). GSE FabriNet UF geocomposites are designed and formulated to perform drainage function under a range of anticipated site loads, gradients and boundary conditions. Index properties for the product are provided in the table below. Please contact GSE for further information regarding performance under site-specific conditions.

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE ROLL VALUE[d]		
Geocomposite			6 oz/yd^2	8 oz/yd^2	10 oz/yd^2
Product Code:			F82060060S	F82080080S	F82100100S
Transmissivity[a], gal/min/ft (m^2/sec)	ASTM D 4716-00	1/540,000 ft^2	4.35 (9.0 x 10^{-4})	4.35 (9.0 x 10^{-4})	4.35 (9.0 x 10^{-4})
Ply Adhesion, lb/in (g/cm)	GRI GC-7	1/50,000 ft^2	1.0 (178)	1.0 (178)	1.0 (178)
Roll Width, ft (m)			14.5 (4.4)	14.5 (4.4)	14.5 (4.4)
Roll Length, ft (m)			160 (48)	150 (45)	140 (42)
Roll Area, ft^2 (m^2)			2,320 (215)	2,175 (202)	2,030 (188)
Geonet core[b]					
Transmissivity[a], gal/min/ft (m^2/sec)	ASTM D 4716-00		38.64 (8 x 10^{-3})	38.64 (8 x 10^{-3})	38.64 (8 x 10^{-3})
Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	300 (7.6)	300 (7.6)	300 (7.6)
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035	1/50,000 ft^2	75 (13.3)	75 (13.3)	75 (13.3)
Carbon Black Content, %	ASTM D 1603	1/50,000 ft^2	2.0	2.0	2.0
Geotextile (prior to lamination)[b,c]					
Mass per Unit Area, oz/yd^2 (g/m^2)	ASTM D 5261	1/90,000 ft^2	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft^2	170 (755)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft^2	90 (395)	120 (525)	165 (725)
AOS, US Sieve (mm)	ASTM D 4751	1/540,000 ft^2	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, (sec^{-1})	ASTM D 4491	1/540,000 ft^2	1.5	1.5	1.2
Flow Rate, gpm/ft^2 (l/min/m^2)	ASTM D 4491	1/540,000 ft^2	110 (4,480)	110 (4,480)	85 (3,460)
UV Resistance, % Retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70

NOTES:

- [a]Gradient of 0.1, normal load of 10,000 psf, water at 70° F (20° C), between stainless steel plates for 15 minutes.
- [b]Component properties prior to lamination. Net thickness is a typical value.
- [c]Several geotextiles are available and may be supplied as determined by GSE.
- [d]These are MARV values and are based on the cumulative results of specimens tested by GSE. AOS in mm is a maximum average roll value.

DS066 R10/07/03

Americas	GSE Lining Technology, Inc.	Houston, Texas	800-435-2008	281-443-8564	Fax: 281-230-8650
Europe/Middle East/Africa	GSE Lining Technology GmbH	Hamburg, Germany		49-40-767420	Fax: 49-40-7674233
Asia/Pacific	GSE Lining Technology Company Ltd.	Bangkok, Thailand		66-2-937-0091	Fax: 66-2-937-0097

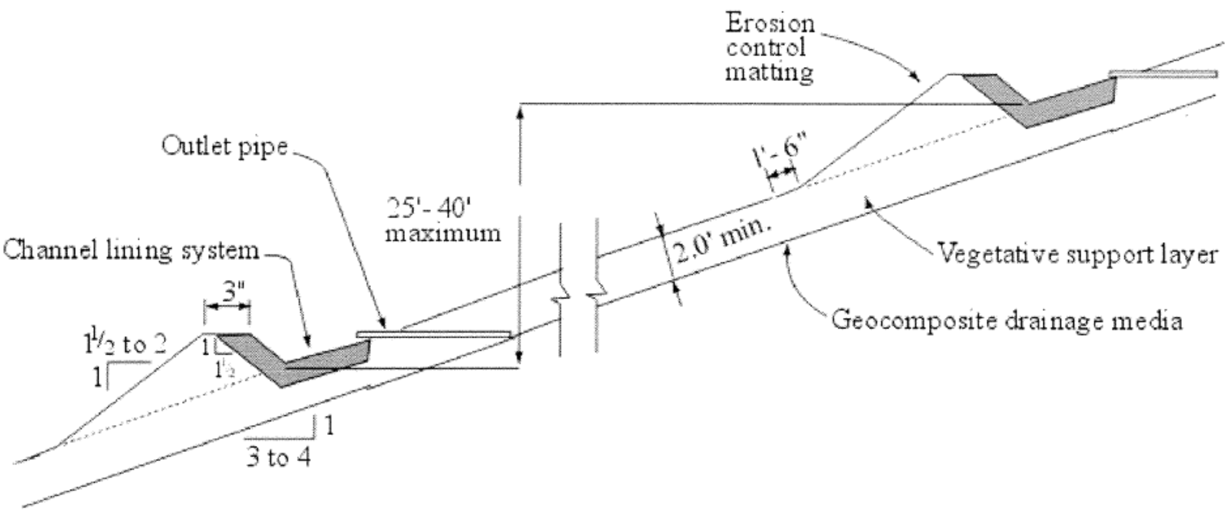
This product data sheet is also available on our website at:

www.gseworld.com

landfilldesign.com

Unit Gradient Method - Design Calculator

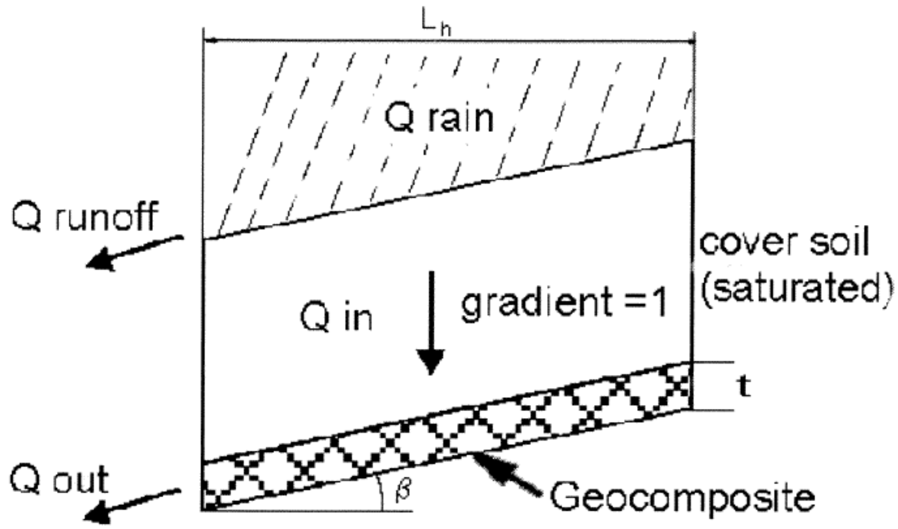
Problem Statement



The transmissivity of a drainage geocomposite must be great enough to carry all of the infiltrating flow from the soil layer(s) above. If the drainage geocomposite can not carry all the infiltrating water (very long slope, or very permeable cover soil,...); swales can be placed as shown in the above figure. The three conditions for stability are:

1. The interface shear strength of all interfaces is adequate
2. Pore water pressures do not build up and reduce the contact stress between the geomembrane and the soil. The Seepage Force Stability Calculator can be used to determine the factor of safety of a landfill cover with consideration of seepage forces
3. Landfill gas pressures beneath the liner are vented properly.The Landfill Gas Pressure Relief Calculator can be used to determine the gas transmissivity of the relief layer. The Landfill Gas Stability Calculator can be used to verify the factor of safety of a landfill cover subject to landfill gas pressure underneath a geomembrane liner.

This webpage determines the ultimate transmissivity sufficient to transmit all incoming flow within the thickness of the geocomposite; i.e. maximum head < geonet thickness; therefore seepage forces in the cover soil will be zero.



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\ \beta$$

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\ \beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Required Data

Symbol	Name	Dimensions
L_h	Drainage pipe spacing or length of slope measured horizontally	Length
k_{veg}	Permeability of the vegetative supporting soil	Length/Time
S	The liner's slope, **S** = tan **b**	-
FS_{slope}	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	-

FS_d	Overall factor of safety for drainage
RF_{in}	Intrusion Reduction Factor
RF_{cr}	Creep Reduction Factor
RF_{cc}	Chemical Clogging Reduction Factor
RF_{bc}	Biological Clogging Reduction Factor

Input Values

Note: If you do not wish to perform calculations for 3 cases, please leave default data as is.

	Case 1		Case 2		Case 3	
S	5	%	20	%	20	%
L_h	98	m	119	m	119	m
k_{veg}	0.00001	cm/sec	0.00001	cm/sec	0.00001	cm/sec
FS_{slope}	1.5		1.5		1.5	

Reduction Factors and Safety Factor

	Case 1	Case 2	Case 3		Surface Water Drains
RF_{in}	1.5	1.5	1.5	[1]	1.0 - 1.2
RF_{cr}	1.4	1.4	1.4	[2]	Calculate RF_{CR}
RF_{cc}	1.2	1.2	1.2	[3]	1.0 - 1.2
RF_{bc}	1.6	1.6	1.6	[3]	1.2 - 3.5
FS_d	2	2	2	[4]	2.0 - 10.0

Calculate Transmissivity

[1] Intrusion reduction factor from 100 hour to design life. Giroud et. al (2000)

[2] Creep reduction factor from 100 hour to design life (for instance, 30 years). RF_{CR} is determined from 10,000 hour compressive creep test, extrapolated to design life, GRI-GC8 (2001). RF_{CR} is product and normal load specific.

[3] GRI-GC8

[4] FS value = 2-3. Giroud, et. al (2000)
FS value > 10 for filtration and drainage. Koerner (2001)

[5] Note: The calculated transmissivity is corresponding to the case where the seating time is 100 hours and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test.

Solution

Symbol	Name	Dimensions
gradient	Gradient	
$\theta_{ultimate}$	Ultimate Transmissivity	$Length^2/Time$
$\delta_{req'd}$	Minimum interface friction angle	degrees

	Case 1		Case 2		Case 3	
gradient	0.05		0.20		0.20	
$\theta_{ultimate}$	1.58E-003	**m^2/s**	4.89E-004	**m^2/s**	4.89E-004	**m^2/s**
$\delta_{req'd}$	4.29	**degrees**	16.70	**degrees**	16.70	**degrees**

Additional Assistance

If you would like to have Advanced Geotech Systems provide material specifications that meet your performance criteria, please fill in the following fields and click the submit button. All information is kept strictly confidential.

Name *

Company

Email Address *

Phone

Project Reference

Comments

*required fields

Submit Design Results

References

"GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.

"Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3.

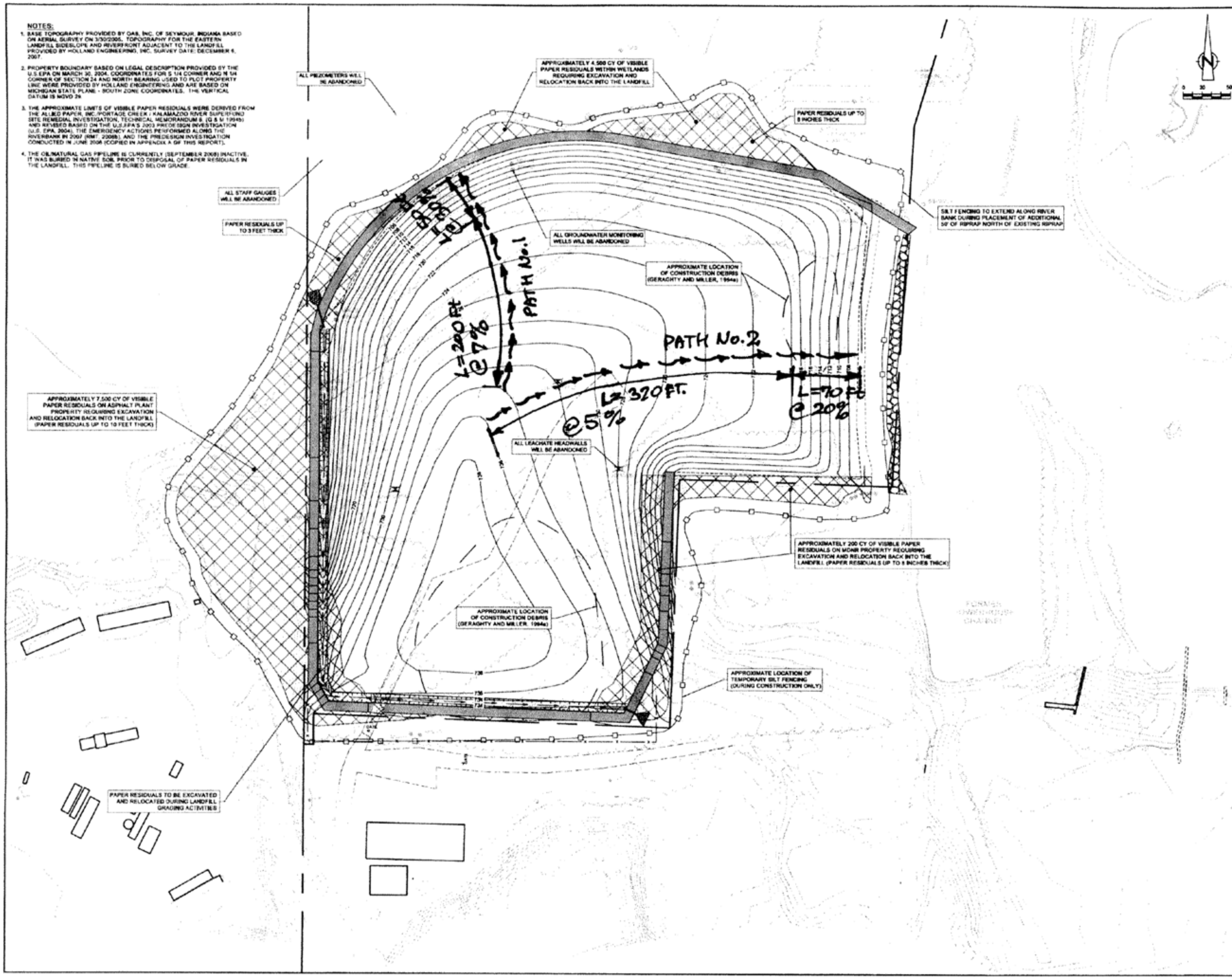
"Designing with Geosynthetics". **R.M. Koerner**, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". **J. P. Giroud**, **J. G. Zornberg** and **A. Zhao**, *Geosynthetics International*, Vol. 7, Nos 4-5.

"Lateral Drainage Design update - part 2". **G. N. Richardson**, J.P. Giroud and **A. Zhao**, *Geotechnical Fabrics Report*, March, 2002

NOTES:

1. BASE TOPOGRAPHY PROVIDED BY GAS, INC. OF SEYMOUR, INDIANA BASED ON AERIAL SURVEY ON 3/30/2005. TOPOGRAPHY FOR THE EASTERN LANDFILL SIDESLOPE AND RIVERFRONT ADJACENT TO THE LANDFILL PROVIDED BY HOLLAND ENGINEERING, INC. SURVEY DATE: DECEMBER 6, 2007.
2. PROPERTY BOUNDARY BASED ON LEGAL DESCRIPTION PROVIDED BY THE U.S.EPA ON MARCH 30, 2004. COORDINATES FOR S 1/4 CORNER AND N 1/4 CORNER OF SECTION 24 AND NORTH BEARING USED TO PLOT PROPERTY LINE WERE PROVIDED BY HOLLAND ENGINEERING AND ARE BASED ON MICHIGAN STATE PLANE - SOUTH ZONE COORDINATES. THE VERTICAL DATUM IS NGVD 29.
3. THE APPROXIMATE LIMITS OF VISIBLE PAPER RESIDUALS WERE DERIVED FROM THE ALLIED PAPER, INC./PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE REMEDIAL INVESTIGATION, TECHNICAL MEMORANDUM 8, (G & M 1994b) AND REVISED BASED ON THE U.S.EPA'S 2003 PREDESIGN INVESTIGATION (U.S. EPA, 2004), THE EMERGENCY ACTIONS PERFORMED ALONG THE RIVERBANK IN 2007 (RMT, 2008b), AND THE PREDESIGN INVESTIGATION CONDUCTED IN JUNE 2008 (COPIED IN APPENDIX A OF THIS REPORT).
4. THE OIL/NATURAL GAS PIPELINE IS CURRENTLY (SEPTEMBER 2008) INACTIVE. IT WAS BURIED IN NATIVE SOIL PRIOR TO DISPOSAL OF PAPER RESIDUALS IN THE LANDFILL. THIS PIPELINE IS BURIED BELOW GRADE.



No	Revision	Date	Initial

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING FENCE
- EXISTING BUILDING
- EXISTING 10' CONTOUR
- EXISTING TREES AND/OR BRUSH
- EXISTING WET AREA AND WETLAND
- EXISTING EDGE OF WATER
- EXISTING LIMITS OF PAPER RESIDUALS
- EXISTING MONITORING WELL LOCATION (TO BE ABANDONED)
- EXISTING PIEZOMETER LOCATION (TO BE ABANDONED)
- EXISTING LEACHATE HEAD WELL LOCATION (TO BE ABANDONED)
- EXISTING STAFF GAUGE (TO BE ABANDONED)
- EXISTING GAS VENT
- PROPOSED LOCATION OF TEMPORARY SILT FENCING (DURING CONSTRUCTION ONLY)
- APPROXIMATE LIMITS OF CONSTRUCTION DEBRIS
- 718 PROPOSED FINAL ELEVATION CONTOURS
- PROPOSED FENCE
- PROPOSED LIMITS OF WASTE
- PROPOSED DRAINAGE SWALE
- PROPOSED SITE ACCESS ROAD

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

12th STREET LANDFILL
Otsego Township, Michigan

DESIGN MODIFICATIONS REPORT

SITE
WORKS

CONESTOGA-ROVERS & ASSOCIATES

Source Reference: BASE ADAPTED FROM PREVIOUS RMT DESIGN			
Project Manager: G. CARLI	Reviewed By: R. HOEKSTRA	Date: APRIL 2009	
Scale: 1" = 50'-0"	Project Nº: 56393-00	Report Nº: 002	Drawing Nº: C-02

ENGINEERING DESIGN CALCULATION

PROJECT IDENTIFICATION

Client: Weyerhaeuser Company — 056393

Project: 12 ST Landfill — Location: Otsego Township, Michigan

CALCULATION IDENTIFICATION

Calculation Ref. No.: ______ No. Pages: 8
(Including calculation cover sheet)

Calculation Description:

ANNUAL SOIL LOSS FROM FINAL COVER

Design: A.Wesolowski — Date: May 26/09

Checked: R. Hoekstra — Date:

RECORD OF REVISION

Revision No.	Revision Date	Design	Checked	Supervised	Project Control	Detail of Revision
0	--	--	--	--	--	Original (per above)

CRA	PROJECT NO: 056393	DESIGNED BY: A.W.
	PROJECT NAME: 12 St Landfill	CHECKED BY: R.H.
	DATE : May 26/09	PAGE 1 OF 8

1. ANNUAL SOIL LOSS FROM FINAL COVER

1.1 Data input

- formula and factors from USEPA SW-867 "Evaluation Cover Systems for Solid and Hazardous Waste" dated Sept 1982

A = R x K x LS x C x P

Where:

A = average annual soil loss, in tons/acre
R = rainfall and runoff erosivity index, for Metamora site = 100 (fig.20)
K = soil erodibility factor in tons/acre (Table 5), for post construction conditions , sandy clay loam, organic matter 4% K= 0.21

LS = length /slope factor (Table 6) or calculated using USEPA recommended method for non-linear slope

Path	Total length Ft.	No. of segments	Slope %	LS factor	Multiplier	Corrected LS factor	Avg factor
1	250 (200+50)	2	7	1.31	0.71	0.93	
			30	12.50	1.29	16.13	**8.53**
2	390 (320+70)	2	5	1.08	0.71	0.77	
			20.0	8.09	1.29	10.09	**5.58**

C = cover management factor (Table 7), for post construction conditions, grass fully established , C = 0.01 (for meadows – grass Moderate productivity level) ,

P = practice factor (Table 8) , for post construction conditions , P = 1.0 (no support practice).

2. SOIL LOSS CALCULATIONS

Table 1 summarizes results for post construction conditions.

TABLE 1

Path No.	R	K	LS	C	P	Average annual loss tons/acre
1	100	0.21	8.53	0.01	1.0	1.79
2	100	0.21	5.58	0.01	1.0	1.17

This is an acceptable level.

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response Washington DC 20460
SW-867 September 1982 Revised Edition

EPA Evaluating Cover Systems for Solid and Hazardous Waste

Evaluate Erosion Potential — Step 18

The USDA universal soil loss equation (USLE) is a convenient tool for use in evaluating erosion potential. The USLE predicts average annual soil loss as the product of six quantifiable factors. The equation is:

$$A = R\ K\ L\ S\ C\ P$$

where A = average annual soil loss, in tons/acre
R = rainfall and runoff erosivity index
K = soil erodibility factor, tons/acre
L = slope-length factor
S = slope-steepness factor
C = cover/management factor
P = practice factor

The data necessary as input to this equation are available to the evaluator in a figure and tables included below. Note that the evaluations in Step 8 on soil composition and Steps 23–29 on vegetation all impact on the evaluation of erosion also.

Factor R in the USLE can be calculated empirically from climatological data. For average annual soil loss determinations, however, R can be obtained directly from Figure 20. Factor K, the average soil loss for a given soil in

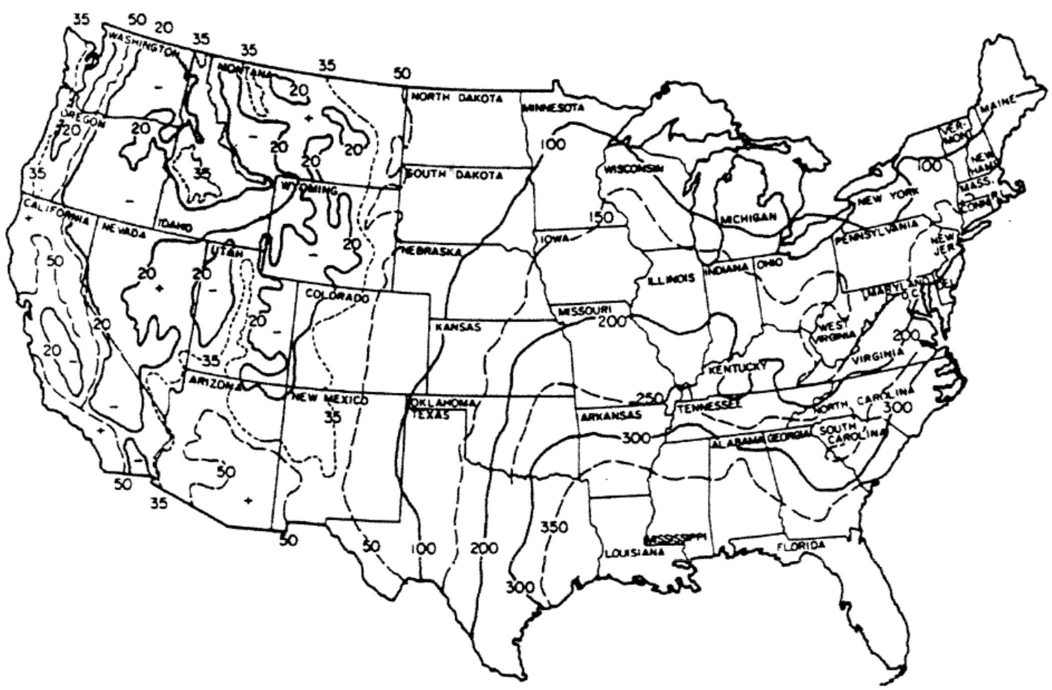


Figure 20. Average annual values of rainfall-erosivity factor R .[11]

a unit plot, pinpoints differences in erosion according to differences in soil type. Long-term plot studies under natural rainfall have produced K values generalized in Table 5 for the USDA soil types.

TABLE 5. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[11]

Texture class	Organic matter content <0.5% K	2% K	4% K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

The evaluator must next consider the shape of the slope in terms of length and inclination. The appropriate LS factor is obtained from Table 6. A nonlinear slope may have to be evaluated as a series of segments, each with uniform gradient. Two or three segments should be sufficient for most engineered landfills, provided the segments are selected so that they are also of equal length (Table 6 can be used, with certain adjustments). Enter Table 6 with the total slope length and read LS values corresponding to the percent slope of each segment. For three segments, multiply the chart LS values for the upper, middle, and lower segments by 0.58, 1.06, and 1.37,

TABLE 6. VALUES OF THE FACTOR LS FOR SPECIFIC COMBINATIONS OF SLOPE LENGTH AND STEEPNESS[11]

% Slope	Slope length (feet)											
	25	50	75	100	150	200	300	400	500	600	800	1000
0.5	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20
1	0.09	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.21	0.22	0.24	0.26
2	0.13	0.16	0.19	0.20	0.23	0.25	0.28	0.31	0.33	0.34	0.38	0.40
3	0.19	0.23	0.26	0.29	0.33	0.35	0.40	0.44	0.47	0.49	0.54	0.57
4	0.23	0.30	0.36	0.40	0.47	0.53	0.62	0.70	0.76	0.82	0.92	1.0
5	0.27	0.38	0.46	0.54	0.66	0.76	0.93	1.1	1.2	1.3	1.5	1.7
6	0.34	0.48	0.58	0.67	0.82	0.95	1.2	1.4	1.5	1.7	1.9	2.1
8	0.50	0.70	0.86	0.99	1.2	1.4	1.7	2.0	2.2	2.4	2.8	3.1
10	0.69	0.97	1.2	1.4	1.7	1.9	2.4	2.7	3.1	3.4	3.9	4.3
12	0.90	1.3	1.6	1.8	2.2	2.6	3.1	3.6	4.0	4.4	5.1	5.7
14	1.2	1.6	2.0	2.3	2.8	3.3	4.0	4.6	5.1	5.6	6.5	7.3
16	1.4	2.0	2.5	2.8	3.5	4.0	4.9	5.7	6.4	7.0	8.0	9.0
18	1.7	2.4	3.0	3.4	4.2	4.9	6.0	6.9	7.7	8.4	9.7	11.0
20	2.0	2.9	3.5	4.1	5.0	5.8	7.1	8.2	9.1	10.0	12.0	13.0
25	3.0	4.2	5.1	5.9	7.2	8.3	10.0	12.0	13.0	14.0	17.0	19.0
30	4.0	5.6	6.9	8.0	9.7	11.0	14.0	16.0	18.0	20.0	23.0	25.0
40	6.3	9.0	11.0	13.0	16.0	18.0	22.0	25.0	28.0	31.0	--	--
50	8.9	13.0	15.0	18.0	22.0	25.0	31.0	--	--	--	--	--
60	12.0	16.0	20.0	23.0	28.0	--	--	--	--	--	--	--

Values given for slopes longer than 300 feet or steeper than 18% are extrapolations beyond the range of the research data and, therefore, less certain than the others.

respectively. The average of the three products is a good estimate of the overall effective LS value. If two segments are sufficient, multiply by 0.71 and 1.29.

Factor C in the USLE is the ratio of soil loss from land cropped under specified conditions to that from clean-tilled, continuous fallow. Therefore, C combines effects of vegetation, crop sequence, management, and agricultural (as opposed to engineering) erosion-control practices. On landfills, freshly covered and without vegetation or special erosion-reducing procedures of cover placement, C will usually be about unity. Where there is vegetative cover or significant amounts of gravel, roots, or plant residues or where cultural practices increase infiltration and reduce runoff velocity, C is much less than unity. Estimate C by reference to Table 7 for cover management conditions anticipated in the application, and consider changes that may take place in time. See Reference 1 for additional guidance.

Factor P in the USLE is similar to C except that it accounts for additional erosion-reducing effects of land management practices that are superimposed on the cultural practices, e.g., contouring, terracing, and

TABLE 7. GENERALIZED VALUES OF FACTOR C FOR STATES EAST OF THE ROCKY MOUNTAINS[11]

Crop, rotation, and management	Productivity level	
	High	Mod.
	C value	
Base value: continuous fallow, tilled up and down slope	1.00	1.00
CORN		
C, RdR, fall TP, conv	0.54	0.62
C, RdR, spring TP, conv	.50	.59
C, RdL, fall TP, conv	.42	.52
C, RdR, wc seeding, spring TP, conv	.40	.49
C, RdL, standing, spring TP, conv	.38	.48
C-W-M-M, RdL, TP for C, disk for W	.039	.074
C-W-M-M-M, RdL, TP for C, disk for W	.032	.061
C, no-till pl in c-k sod, 95-80% rc	.017	.053
COTTON		
Cot, conv (Western Plains)	0.42	0.49
Cot, conv (South)	.34	.40
MEADOW		
Grass & Legume mix	0.004	0.01
Alfalfa, lespedeza or Sericea	.020	
Sweet clover	.025	
SORGHUM, GRAIN (Western Plains)		
RdL, spring TP, conv	0.43	0.53
No-till pl in shredded 70-50% rc	.11	.18
SOYBEANS		
B, RdL, spring TP, conv	0.48	0.54
C-B, TP annually, conv	.43	.51
B, no-till pl	.22	.28
C-B, no-till pl, fall shred C stalks	.18	.22
WHEAT		
W-F, fall TP after W	0.38	
W-F, stubble mulch, 500 lbs rc	.32	
W-F, stubble mulch, 1000 lbs rc	.21	

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton
F - fallow
M - grass & legume hay
pl - plant
W - wheat
wc - winter cover

lbs rc - pounds of crop residue per acre remaining on surface after new crop seeding
% rc - percentage of soil surface covered by residue mulch after new crop seeding
70-50% rc - 70% cover for C values in first column; 50% for second column
RdR - residues (corn stover, straw, etc.) removed or burned
RdL - all residues left on field (on surface or incorporated)
TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

contour strip-cropping. Approximate values of P, related only to slope steepness, are listed in Table 8. These values are based on rather limited field data, but P has a narrower range of possible values than the other five factors.

TABLE 8. VALUES OF FACTOR P[11]

Practice	Land slope (percent)				
	1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
	(Factor P)				
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_{sc})					
R-R-M-M[1]	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	).50	0.60	0.80	0.90
Contour listing or ridge planting (P_{cl})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[2]	[3] $0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[1] R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on :he field that rowcrop strips are always separated by a meadow or winter-grain strip.

[2] These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[3] n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

Example: An owner/operator proposes to close one section of his small landfill with a sandy clay subsoil cover having the surface configuration shown in Figure 21. The factor R has been established as 200 for this locality. The evaluator questions anticipated erosion along the steep side and assigns the following values to the other factors in the USLE after inspecting Tables 5 through 8:

$K = 0.14 \quad LS = 8.3 \quad C = 1.00 \quad P = 0.90$

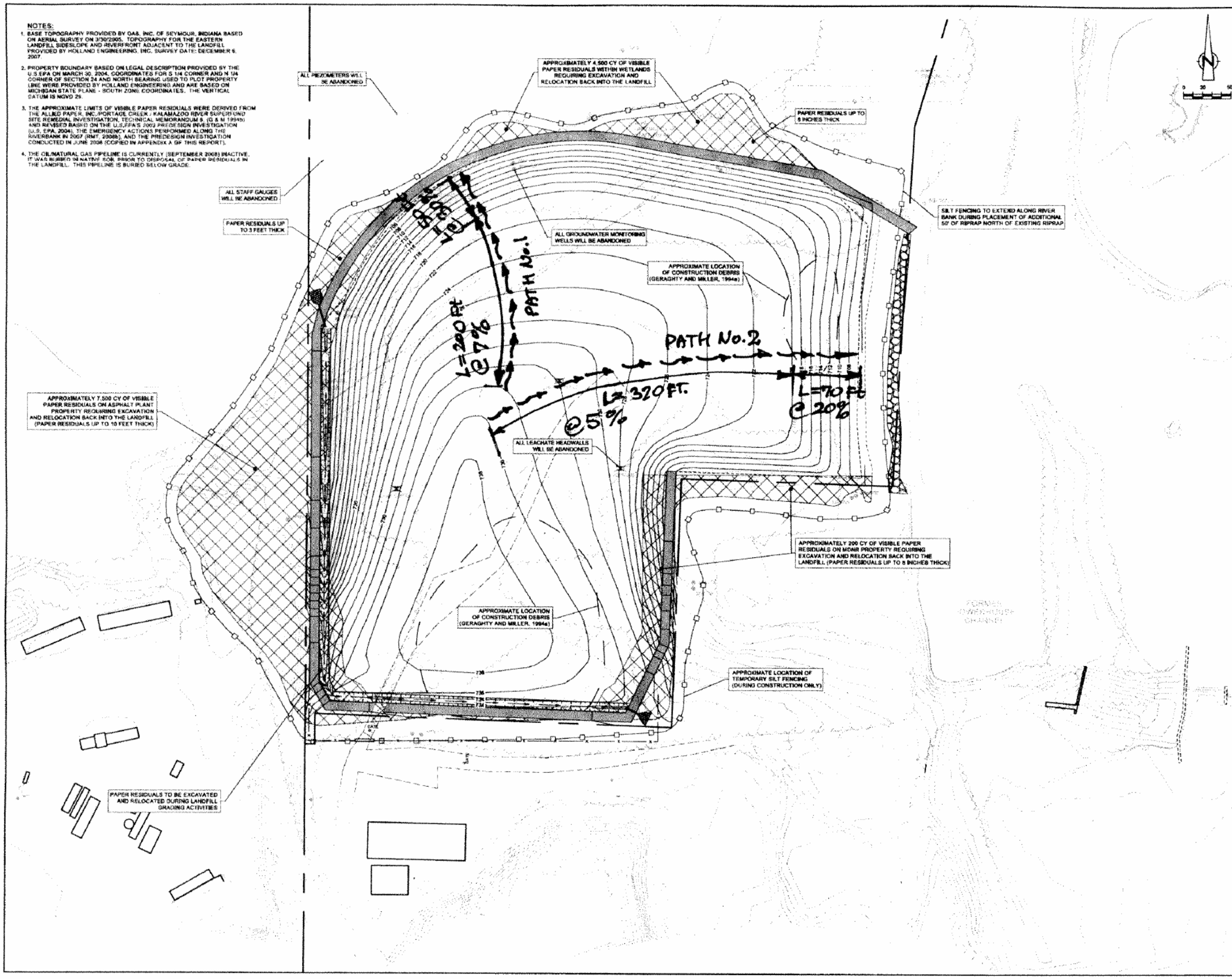
The rate of erosion for the steep slope of the landfill is calculated as follows:

$$A = 200\ (0.14\ \text{tons/acre})\ (8.3)\ (1.00)\ (0.90) = 209\ \text{tons/acre}$$

This erosion not only exceeds a limit recommended by the permitting authority but also indicates a potential

NOTES:

1. BASE TOPOGRAPHY PROVIDED BY OAS, INC. OF SEYMOUR, INDIANA BASED ON AERIAL SURVEY ON 3/30/2005. TOPOGRAPHY FOR THE EASTERN LANDFILL SIDESLOPE AND RIVERFRONT ADJACENT TO THE LANDFILL PROVIDED BY HOLLAND ENGINEERING, INC. SURVEY DATE: DECEMBER 6, 2007.
2. PROPERTY BOUNDARY BASED ON LEGAL DESCRIPTION PROVIDED BY THE U.S.EPA ON MARCH 30, 2004. COORDINATES FOR S 1/4 CORNER AND N 1/4 CORNER OF SECTION 24 AND NORTH BEARING USED TO PLOT PROPERTY LINE WERE PROVIDED BY HOLLAND ENGINEERING AND ARE BASED ON MICHIGAN STATE PLANE - SOUTH ZONE COORDINATES. THE VERTICAL DATUM IS NGVD 29.
3. THE APPROXIMATE LIMITS OF VISIBLE PAPER RESIDUALS WERE DERIVED FROM THE ALLIED PAPER, INC./PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE REMEDIAL INVESTIGATION, TECHNICAL MEMORANDUM 5, (G & M 1994b) AND REVISED BASED ON THE U.S.EPA'S 2003 PREDESIGN INVESTIGATION (U.S. EPA, 2004), THE EMERGENCY ACTIONS PERFORMED ALONG THE RIVERBANK IN 2007 (RMT, 2008b), AND THE PREDESIGN INVESTIGATION CONDUCTED IN JUNE 2008 (COPIED IN APPENDIX A OF THIS REPORT).
4. THE OIL/NATURAL GAS PIPELINE IS CURRENTLY (SEPTEMBER 2008) INACTIVE. IT WAS BURIED IN NATIVE SOIL PRIOR TO DISPOSAL OF PAPER RESIDUALS IN THE LANDFILL. THIS PIPELINE IS BURIED BELOW GRADE.



No.	Revision	Date	Initial

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING FENCE
- EXISTING BUILDING
- EXISTING 10' CONTOUR
- EXISTING TREES AND/OR BRUSH
- EXISTING WET AREA AND WETLAND
- EXISTING EDGE OF WATER
- EXISTING LIMITS OF PAPER RESIDUALS
- EXISTING MONITORING WELL LOCATION (TO BE ABANDONED)
- EXISTING PIEZOMETER LOCATION (TO BE ABANDONED)
- EXISTING LEACHATE HEAD WELL LOCATION (TO BE ABANDONED)
- EXISTING STAFF GAUGE (TO BE ABANDONED)
- EXISTING GAS VENT
- PROPOSED LOCATION OF TEMPORARY SILT FENCING (DURING CONSTRUCTION ONLY)
- APPROXIMATE LIMITS OF CONSTRUCTION DEBRIS
- 718 PROPOSED FINAL ELEVATION CONTOURS
- PROPOSED FENCE
- PROPOSED LIMITS OF WASTE
- PROPOSED DRAINAGE SWALE
- PROPOSED SITE ACCESS ROAD

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

12th STREET LANDFILL
Otsego Township, Michigan

DESIGN MODIFICATIONS REPORT

SITE
WORKS

CONESTOGA-ROVERS & ASSOCIATES

Source Reference: BASE ADAPTED FROM PREVIOUS RMT DESIGN

Project Manager:	Reviewed By:	Date:	
G. CARLI	R. HOEKSTRA	APRIL 2009	
Scale: 1" = 50'-0"	Project Nº: 56393-00	Report Nº: 002	Drawing Nº: C-02

56393-00(002)CI-WA002 MAY 04/2009